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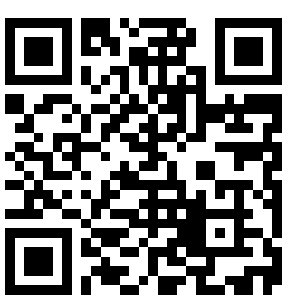

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THE ELECTRICIAN:

A WEEKLY JOURNAL OF

THEORETICAL AND APPLIED ELECTRICITY AND CHEMICAL PHYSICS.

No. 1.—Vol. XIV. SATURDAY, NOVEMBER 15, 1884. Price 4d.

NOTES.

Telegraph Appointment.—Mr. T. Isley, telegraphist at Norwich, has been appointed Postmaster of East Grinstead.

Brazilian Submarine Telegraph Company.—The traffic receipts of this company for the week ended 7th November amounted to £3,800.

Turin Exhibition.—The Eastern Telegraph Company has been awarded at the Turin Exhibition the *diploma d'onore*, which is the highest possible honour.

Electric Railway at Nuremberg.—An electric railway is projected along the picturesque *anlage*, between Nuremberg and Fürth, to be executed by Siemens and Halske, of Berlin.

Electric Light at Barcelona.—La Sociedad Española de Electricidad has fitted twenty Gramme arc lamps, driven by a Gramme dynamo, to the large shop known as El Siglio, at Barcelona.

Western and Brazilian Telegraph Company.—The traffic receipts for the week ending 7th Nov., 1884, were £3,034, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

Demagnetisation of Watches.—*Kosmos* advises that a magnetised watch be placed in the centre of a metallic spiral traversed by alternate currents, which should be very intense at first, and then gradually diminish in intensity until they become *nil*.

Platino-Brazilian Telegraph Company.—The directors have decided to declare an interim dividend, free of income-tax, of 1s. 3d. per share, payable on and after the 17th inst. The transfer books will be closed from the 11th to the 17th inst., both days inclusive.

Telegrams for Perim.—We learn from a Post Office circular of the 11th inst., that telegraphic communication has been established with the Island of Perim, China, and that telegrams are accepted for that place by the Eastern Company and the Submarine Company, at 3s. 9d. a word.

Temporary Lighting.—The Electrical Power Storage Company recently lighted the private residence, at Blackheath, of Mr. Yarrow, the well-known launch builder. We understand this company is making a speciality of temporary lighting, for which their batteries are admirably adapted.

Domestic Lighting.—The Electrical Power Storage Company has lately carried out an installation at the residence of Mr. Phipps, architect, of Mecklenburgh-square, consisting of 40 Swan lamps, supplied by the E.P.S. accumulators, the dynamo being driven by a 1 horse-power Otto gas engine.

New Postmaster-General.—No decision has yet been officially announced with regard to the office of Postmaster-General, rendered vacant by the death of Mr. Fawcett; but it is generally understood that Mr. Shaw-Lefevre will succeed to the position, with (the *Daily News* thinks) a seat in the Cabinet.

G. W. R. Electrical Contracts.—Mr. H. Thorpe, of Theobald's-road, W.C., patentee of the new semaphore indicator illustrated on another page, has secured part of the Great Western Railway contracts, consisting of needle instrument details, gongs, tapper bells, and various electrical sundries.

Ireland Outdone.—In a manifesto addressed by their leaders to the Skye crofters, the following are among the "Rules for Guidance in the Struggle for Freedom from Landlord Tyranny":—"Cut down the telegraph wires and posts, carry away the wires and the instruments. Stop the mail carts, destroy the letters, &c."

Personal.—We understand that Mr. Robert Ord Ritchie (late manager of Messrs. Woodhouse and Rawson's installation department) has been taken into partnership by Mr. A. Thompson, in his electrical and general engineering business, which will hereafter be carried on at 14, St. Swithin's-lane, under the title of Thompson and Ritchie.

The Spanish National Company's Cables.—We are informed that the Silvertown Company has received a telegram from Mr. Robert Kaye Gray, their engineer-in-chief, announcing the completion of the Gran Canary-Lanzarote cable, by their ss. "Silvertown" on Wednesday, the 5th inst. All well on board. The "Silvertown" left Greenhithe on the 24th ult.

Meteorological Society.—At the meeting to be held on the 19th inst., at 7 p.m., the following, among other papers, will be read:—"On the Injury by Lightning (April 28th, 1884) to the Monument to the first Duke of Sutherland at Lilleshall, Shropshire," by C. C. Walker; "On the Mechanical Characteristics of Lightning Strokes," by Colonel the Hon. Arthur Parnell.

Suez Canal and Electric Light.—Among the questions discussed by the Consultative Committee of English Directors of the Suez Canal appointed for the protection of British interests in the Canal, which held its first meeting on Tuesday, at the office of the directorate, 1, Whittington-avenue, Leadenhall-street, Mr. C. M. Palmer occupying the chair, was that of the electric lighting of the vessels passing through the Canal.

Electric Lighting at the Bank of England.—The lighting of a portion of the Bank of England by means of a hundred and sixty 20-candle lamps, carried out by the Electrical Power Storage Company some twelve months back, has

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given every satisfaction. The installation has worked throughout without any stoppage; and the accumulators, from which the current is entirely supplied, have not been in any way renewed.

AMIENS INDUSTRIAL SOCIETY.—In the programme of questions on which competitive communications are invited, we find that a gold medal will be awarded for the best paper on a dynamometer to supersede the Prony brake, but requiring a less inconvenient installation. Foreigners are admitted to compete; and MSS., which must be in the French language, are to be sent to the president, Société Industrielle, Amiens, not later than 31st May next.

EARTH CURRENTS.—M. Blavier concludes as follows a communication on this subject made to the Société Internationale des Electriciens:—"The study of earth currents is calculated to lend valuable assistance to scientific research connected with the physical constitution of the eaath. This study should be generalised and carried on in magnetic observatories, which might be done independently of the telegraph staff, since lines of a few kilometres' length are sufficient to permit of the observation and registration of these currents."

THE BRITISH ASSOCIATION.—The General Committee of the British Association for the Advancement of Science met at the Royal Institution on Wednesday afternoon, when Sir Lyon Playfair was appointed president-elect for the next meeting, which will be held at Aberdeen, commencing on the 9th of September, 1885. Invitations for 1886 were presented from Birmingham, Bournemouth, and Manchester. After hearing the representatives of the different places, it was unanimously resolved to hold the 1886 meeting in Birmingham.

ELECTRIC LIGHTING ACT.—At a meeting of the Edison and Swan United Electric Light Company, held on Tuesday afternoon, Mr. J. S. Forbes, the chairman, said that the effect of the Electric Lighting Act and the Provisional Order was to make electric lighting impossible. He also stated that, although they had made a loss of £28,000 last year, the profit and loss account for the first quarter of the present financial year showed a profit of £750, and there was reasonable ground for believing that they had a good future before them. A full report of the meeting will be found in another part of our present issue.

ELECTRIC LIGHT AT PHILADELPHIA.—The American Electric Construction and Supply Company have been awarded the contract for wiring and putting in the plant for 450 incandescent lamps at Messrs. Folwell Brothers' new and extensive woollen mills in Philadelphia. The system is the Brush-Swan. They have just completed the installation of an extensive plant at the Pequea Mills in same city. The mains for the 450 lights will be four strands of No. 0 wire. The whole work is under the supervision of Mr. Arthur Kitson, formerly general superintendent of the United States Electric Light Company of Pa.

NEW PRIMARY BATTERY.—M. Senet has brought out a new battery, which depends on the use of a double sulphate of ammonia and sesquioxide of iron. The rectangular cell is of wood, containing the solution of alum and two carbon plates, while a porous jar contains water acidulated by one-tenth of sulphuric acid, and a plate cast from zinc and mercury melted together. This battery is said to be very constant, and has an E.M.F. of 1·7 volt. This depolariser has the advantage of costing only 1d. or 1½d. per lb., while its decomposition supplies the sulphuric acid necessary for attacking the zinc.

LORD MAYOR'S DAY.—The *Pall Mall Gazette* complains that on Monday "so dense was the crowd that a telegram despatched from the Post Office to Northumberland-street took exactly two hours and three-quarters in delivery, being despatched at a quarter past one and being delivered together with sixteen others at four o'clock. That is to say, the message took about six times as long by telegraph as it would have taken an ordinary messenger to have walked the whole distance if the road had been clear." On this we would remark that as men of business make their arrangements in anticipation of a block to traffic, it is rather remarkable that men of the Press do not exercise their foresight in a similar way.

ELECTRIC LIGHT AT THE ANTWERP EXHIBITION.—The executive committee of this exhibition has sent circulars to a large number of electric lighting companies asking prices and conditions for installing and maintaining the lights during the exhibition. The price is asked for per carcel-hour, or say for 10 candle-power per hour, supposing the motive power to be supplied without cost to the lighting companies. All the leads are to be covered and placed overhead, while the exhibitors are to receive an indemnity of 1 franc (nearly 10d.) for every kilogramme (2·2lb.) of copper employed. Tenders were to be sent in by 15th inst., and the contracts will be let by the committee, acting under the advice of a sub-committee consisting of Messieurs Dery, Dumont, Evrard, Gérard, Gody, and Wijbauw.

LIGHTNING CONDUCTORS IN SCANDINAVIA.—Professor Mohn, of Christiania, who was commissioned by the Swedish Government to hold an official inquiry as to the degree of protection afforded by lightning conductors, ascertained that lighthouses, telegraph stations, and other buildings, very much exposed, but provided with lightning conductors, suffered considerably less than the churches, which are in Norway generally not protected against lightning. Out of a hundred churches struck, only three were provided with lightning conductors. In one, the conductor of which was in good condition, no damage was done. In the second, the conductor, which was of zinc, was melted. In the third, the conductor was eaten by rust where it entered the soil; and the church was set on fire.

PURE CARBON.—M. Jacquelain has endeavoured to procure a pure carbon for electrical purposes that should be as hard and as conductive as gas carbon. He first takes gas carbon, which he submits to four processes: (1) Treatment with dry chlorine at a red heat for thirty hours; (2) treatment with hot alkali for about three hours; (3) immersion in hydrofluoric acid—one to two of water—at a temperature of 15° to 25°; (4) carbonisation by heating strongly in the vapour of a high boiling hydro-carbon—for commercial purposes gas tar will do well. All these operations may be performed after the carbon has been cut into sticks. By these processes, which do not seem to be new in any particular, the *Scientific American* says, the impurities have been reduced to a minimum, and a good pure carbon is obtained.

A TOWN ELECTRICALLY LIGHTED BY A STREAM.—At Bellegarde, in France, M. Dumont, a manufacturer, has thrown a dam across the Valserine, a stream yielding 1,100 gallons per second, and affording, with 165ft. fall, an hydraulic power of at least 2,000 horses; a 600 horse-power turbine is already at work, and drives, among other machines, two Gramme dynamos, the current from which is led direct, by copper conductors placed on poles, to Edison incandescent lamps distributed about the town. The lighting is brilliant enough, but requires a regulator, and also proper distribution, so as to be able to switch individual or series of lamps on or off. The dynamos might well be employed during the day for generating current, to be utilised on the spot or transmitted to a distance, as the whole 2,000 horse-power is available.

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THE PATENT ACT AND THE INVENTORS' INSTITUTE.—At a meeting of the Executive Council of the Inventors' Institute, held at their rooms, Lonsdale Chambers, Chancery-lane, on Monday, the 10th inst., it was resolved "That the first meeting in every month should be devoted to the consideration of the Patents, Designs, and Trade Marks Act of 1883; that the Act should be gone through regularly by sections, and that a report should be drawn up of the result of the discussions, and that visitors should be invited to attend these meetings." The first meeting for the consideration of the Act will take place on Monday, December 8th, the chair being taken at 8 p.m. by Vice-President Admiral Selwyn, when Parts I. and II. as far as Section 7, should time permit, will be discussed. The secretary is authorised to issue a few tickets of admission.

THE ELECTRO-CHEMICAL EQUIVALENT OF SILVER.—A very careful and important determination of the electro-chemical equivalent of silver has been made at the Observatory of the Physical Institute of Wurzburg, and the results are that an ampere current flowing for a second, or a coulomb of electricity, deposits 1·1183 milligrammes of silver or 0·3281 milligrammes of copper, and decomposes 0·09328 milligrammes of water, a result agreeing closely with that of Lord Rayleigh, recently communicated to the Physical Society. An ampere therefore deposits 4·0259 grams of silver per hour; Kohlrausch's value is 4·0824, a value hitherto accepted universally. This value is so useful in measuring electric currents with accuracy, and free from the disturbances of magnetism, &c., that it is eminently satisfactory to find the German value agree with that of Lord Rayleigh, which will probably be adopted by English electricians.

THE ELECTROLYTIC EXTRACTION OF COPPER.—Messrs. Siemens and Halske, of Berlin, have five C_1 machines, each with twelve baths in action, at the Oker Works. Each machine is worked by a water-power of from four to five h.-p., and deposits one kilogramme (2·2lb.) of copper per cell per hour—that is, about 300 kilos. (6cwt.) a day. At the North German Refining Works in Hamburg, six No. 1 Gramme machines and one Wohlwill machine are in operation, precipitating 2,500 kilos. (50cwt.) of copper daily. Oescher and Mesdach have constructed a Gramme machine according to Wohlwill's instructions that yields 800 kilos. (16cwt.) of copper daily. Hilarion Roux, at Marseilles, works with a No. 1 Gramme machine connected with forty baths, having 900 square metres anode surface; the cathodes are only 0·5 mm. thick, and are 5 cm. (2in.) from the anodes. The machine makes 850 revolutions a minute, consumes 240 kilos. (4¾cwt.) of coal a day, and deposits, with 8 volts and 300 amperes, 250 kilos. (5cwt.) of refined copper.

ARTS ET METIERS.—The programme of the course of instruction at the Conservatoire des Arts et Métiers, Paris, for the year 1884-5, has been published, and includes lectures on applied geometry, by Professor Laussedat (director); on descriptive geometry, by Professor Rouché; on applied mechanics, by Professor Tresca (curator); civil construction, by Professor Trélat; applied physics, by Professors E. and H. Becquerel; general chemistry, by Professor Péligot; industrial chemistry, by Professor Girard; applied chemistry, by Professor de Luynes; agricultural chemistry, by Professors Boussingault and Schloesing; agriculture, by Professor Lecouteux; rural engineering, by Professor de Comberousse; spinning and weaving, by Professor Imbs; political economy, by Professor Levasseur; industrial economy, by Professors Burat and De Foville; and commercial law, by Professor Malapert. Strange to say, no lectures on electricity have yet been added, although the University of Liége, in Belgium, has arranged a special course of instruction for electrical students.

EXHIBITION AT THE ALEXANDRA PALACE.—It is really a pity that this building, erected at so much cost, should remain idle and go to rack and ruin. But it is proposed next year to hold an International Exhibition of Arts, Manufactures, Scientific, Agricultural, and Industrial Products, Mechanical Processes, and New Inventions, to be opened about March 31st, and to be kept open for at least six months. It is hoped that, in addition to the ordinary awards made by the international juries, special recognition of these classes of exhibits may be offered by the various guilds, societies, and corporations connected with trade and manufacture. The executive commissioner is Mr. Geo. Collins Levey, C.M.G., and the secretary, Mr. Edgar Ray, the offices of the administration being at 19 and 21, Queen Victoria-street, E.C. Diplomas of honour and honourable mention, as well as for gold, silver, and bronze medals, will be awarded on the reports of the juries, and no restrictions will be placed on selling. Messrs. J. Gavin, Birt, and Co., 27, Leadenhall-street, E.C., have been appointed official agents for the naval and machinery sections, which are intended to form prominent features.

ELECTRIC LIGHT AT THE CHARING CROSS BRIDGE WORKS.—Messrs. Cochrane and Sons, of Westminster, the contractors for widening the Charing Cross Bridge of the South Eastern Railway, being pressed for time, wished to increase the hours of work, and entrusted Mr. J. S. Beeman, M.S.T.E., with the electric light installation. There are five arc lamps of 3,000 to 4,000 candle-power, the current for which is generated by a Crompton dynamo plant, capable of working eight lamps, driven by a 12 horse-power double-cylinder Otto gas engine, which is utilised in the daytime for sawing timber and other purposes. The caissons, in which the excavation takes place under compressed air, are lighted by five incandescent lamps in each, with one outside for the driver. The first portion of this installation was started on Tuesday night last, and gave great satisfaction to both officials and workmen. The arc light was so bright as to interfere with the navigation; and it will be necessary to put up curtains for confining the rays to the bridge. The plant is made movable so that the lamps may be shifted according to the exigencies of the work, in order to permit of the girders being riveted up by night as well as by day. This electric illumination of works in progress shows how contractors may gain several hours of work during the dark days of winter.

UNDERGROUND CABLES.—The Kinetic Engineering Company, of Brook-street, Holborn, has received an order for the underground electric light cables for lighting several streets in Greenock under the Provisional Order obtained by the Police Board. The cables will be of three types, namely, the main cable, consisting of thirty-six strands of copper wire, 1·5 millimetre in diameter; the branch main, of twelve strands of 1·6 millimetre; and the leads for the lamp posts, of one strand 1·2 millimetre in diameter. These cables will be of the Berthoud-Borel type, insulated with Berthoud-Borel material, and encased in a double sheathing of lead, the two sheathings being separated by a layer of gas tar. A conductivity of 96 per cent. and an insulation of 1,000 megohms per mile at the ordinary temperature are guaranteed. These cables will not be laid in any troughs or pipes, but will be tarred and then laid on a layer of fine sand placed in the bottom of the trench, and covered with the same to a depth of about four inches. A plank of wood or layer of bricks will be placed over the sand to indicate the presence of the cable to workmen after-

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wards taking up the street, and thus prevent its destruction by their tools. Large quantities of these cables have been thus laid in many Continental towns, and give complete satisfaction. This method of laying the Berthoud-Borel cables effects a great saving in time and labour.

LIGHTNING CONDUCTORS FOR MILLS.—In an able and well-digested article on this subject in the *Paper Trade Review* for November 7, the author advises that conductors be not only carefully erected at first, but also regularly tested by means which are now readily available, in order to see that they are continuously effective. He continues:—"Tests are readily taken of a properly erected conductor at any period in a few minutes, but for this purpose a double conductor is required, which, however, is little more expensive than the ordinary rod;" and concludes as follows:—"If it is worth while to attempt the protection of a mill or other building from lightning, it is worth doing properly. The erection of a rod on the chimney shaft, even when well done, cannot be depended on to protect more than the chimney itself; and if put up as it usually is, the hot gases in the chimney offer an easier path for the flash and so create danger. Every salient part of the building, such as the ridges, gable ends, top corners, &c., should be provided with a set of plated points about 6ft. high, and at comparatively short distances from each other. All these points and all the metal work exterior to the building should also be connected in the most secure manner possible, so that the joints shall offer no extra resistance to the lightning rod, which should have a sectional area of at least one centimetre, or, say, a circular half inch."

INCANDESCENT SHIP LIGHTING.—The ss. "Kaikoura," built by Messrs. J. Elder and Co., of Govan, Glasgow, for the New Zealand Shipping Company, which proceeded down the Clyde on the 17th of last month on her trial trip, and left for London at 11:30 a.m. on the 18th inst., was fitted with the electric light, comprising two hundred and forty 20-candle and ten lanterns of three 40-candle Swan lamps each. These lanterns are to be used for loading and discharging cargo. The pendants, designed and made by Messrs. W. M'Geoch and Co., of Glasgow, for oil and electric light combined, are hung from the deck. There are in the first-class dining saloon ten pendants fitted with two electric lamps and one oil lamp each, four in the second-class saloon and one pendant hung above the first and second stairs leading into the saloons. The rest were single-light fittings, of which eleven were combined brackets. The whole of the work has been carried out by Messrs. King, Brown, and Co., of Rosebank Electric Works, Edinburgh, and superintended personally by Mr. W. F. King and his assistant, Mr. H. Lyon. The dynamo is one of Siemens Brothers' compound shunt-wound, driven by a Marshall 33-horse steam-engine, the steam being supplied by the main boilers while at sea, and by the donkey boiler when in dock. The installation was pronounced a perfect success by a large company on board.

INTERNATIONAL TELEPHONE COMPANY.—An extraordinary meeting of the Compagnie Internationale des Téléphones was held at Brussels on the 8th inst., when the President read a report turning upon a numerously-signed letter which had been received by the Council of Administration (or Board of Directors), commencing as follows:—"The persistent depreciation of our shares, the market price of which does not correspond with their actual value, has induced us to seek a combination which will permit of raising the quoted price of our shares without hindering the business of the Company, or injuring its vitality." The method of bringing about this result was referred to several eminent jurisconsults, who all agreed that the present company should be wound up and transformed into a new company bearing the same title, but with a capital of only half the original amount. The report states that it is indispensable to call a new meeting, with a definite programme, so that it can vote successively the proposed modification in the constitution of the company. After the reading of the report, the following resolution was adopted by 43,257 to 1,290 out of 44,517 votes:—"The meeting is of opinion that there is ground for apportioning among the shareholders a portion of the company's *portefeuille* stock, and calls upon the council to deliberate upon the legal and practical means for bringing about this result, while at the same time reducing the nominal capital to its real value." Thus, the International Telephone Company has arrived at a stage already passed through by some telephone companies in this country, and has adopted a remedy to which several electric light companies have found it necessary to resort.

BALTIMORE.—A most pleasant dinner party was given at Johns Hopkins University, on Friday, Oct. 16, by President Gilman to the scientific men who had been brought together by Sir Wm. Thomson's lectures. The happiness of the occasion was only marred by the reflection that it was a farewell event. The feelings of all seem to have been concentrated in Professor G. Forbes, of London, Eng., who broke forth into the following wail:—

The lament of the 21 coefficients in parting from each other and from their esteemed molecule.

An æolotropic molecule was looking at the view,
Surrounded by his coefficients, twenty-one or two,
And wondering whether he could make a sky of azure blue
With platitatic *a b c* and thlipsinomic Q.
They looked like sand upon the shore with waves upon the sea,
But the waves were all too wilful and determined to be free,
And in spite of *n*'s rigidity they never could agree
In becoming quite *subservient* to the thlipsinomic P.
Then *web*-like coefficients and a loaded molecule
With a noble wiggler at their head worked hard as Haughton's mule;
But the waves all laughed, and said a wiggler, thinking he could rule
A wave, was *nothing better* than a sidelong, normal fool.
So the coefficients sighed and gave a last tangential skew,
And *a* shook hands with *b* and *c* and S and T and U;
And with a tear they parted, but they said they would be true
To their much-beloved *wiggler* and to thlipsinomic Q.

Signed (*g*, *f*), a cross-coefficient, now annulled.

Sir William Thomson pronounced the mathematics all right; President Gilman, the verse, and the sentiment was unanimously concurred in.—*Electrical World.*

SOCIETY OF ARTS.—The first meeting of the 131st session of the Society for the Encouragement of Arts, Manufactures, and Commerce will be held on Wednesday, the 19th November, when the opening address will be delivered by Sir Frederick Abel, C.B., D.C.L., LL.D., F.R.S., chairman of the council. Previous to Christmas there will, in addition to the opening meeting, be four ordinary meetings. Among the arrangements already made, the following papers have been promised:—W. H. Preece, F.R.S., "Electric Lighting in America;" Sir J. N. Douglass, "Recent Improvements in Coast Signals;" Professor H. S. Hele Shaw, "The Evolution of Machines." The meetings of the Applied Chemistry and Physics Section, formed in 1874 for the discussion of subjects connected with practical chemistry and its application to the arts and manufactures, and enlarged in 1879, so as to include the consideration of subjects connected also with the applications of

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physical science to the arts, will take place on the following Thursday evenings, at eight o'clock:—February 12, March 12 and March 26, April 23, May 7 and May 28. There will be seven courses of Cantor Lectures, which originated in 1863, with a bequest by the late Dr. Cantor. The lectures of the third course, on the "Distribution of Electricity," by Professor George Forbes, will be given on the evenings of February 2, 9, and 16. Examinations, open to any person, are held annually by the society, through the agency of local committees, at various centres in the country. The subjects include the principal divisions of a Commercial Education, Sanitary Knowledge, Political and Domestic Economy, and Music. The society numbers at present between three and four thousand members.

JAY GOULD AND THE PRESIDENTIAL ELECTION.—The *Standard's* New York correspondent, telegraphing on Thursday night last week, remarked that "everybody is asking why the returns have been so slow in arriving at New York. The only explanation offered so far is that Mr. Jay Gould, who is a supporter of Mr. Blaine, has the control of the Western Union Telegraph Company's lines. Yesterday, that company posted most inaccurate bulletins upon the Stock Exchange. The Associated Press also spread reports of a very partisan character. The despatches containing the true news were strangely delayed. Some newspapers at last refused to use the news furnished by the Associated Press. Mr. George Green, the Secretary of the Independent Republicans, informs me that his organisation could not get properly served by the telegraph agencies. It is stated that a long conference took place yesterday between Mr. Jay Gould and Mr. Elkins, the manager of Mr. Blaine's candidacy, who was a member of the ring which carried out the Star Route postal frauds. The *New York Herald* further asserts that specific instructions were telegraphed in cipher to the Republican Committee of Indiana that the vote of that State must be cast for Mr. Blaine. It is impossible to describe the public indignation at these exposures." On Friday, commenting on the same subject, the *Pall Mall Gazette* says:—"The rise in Atlantic cable securities appears to be due, in the main, to the additional large receipts of the actual companies during the Presidential contest. Mr. Jay Gould's minions are alleged to have tampered with, or at any rate delayed, some of the messages, and that would be a fact hardly conducive to confidence in the established American cable companies which have working arrangements with the Western Union system of land lines on the other side. Indeed, it would rather tend to divert business to the Mackay-Bennett cables, the new rivals of the Anglo-American and its associated companies." The *Pall Mall* seems to be unaware of the fact that practically there are no "Mackay-Bennett" cables. One of them is certainly broken, and the other is not working for the public, if indeed it is working at all.

ELECTRIC RAILWAYS IN THE UNITED KINGDOM.—We are glad to note that electric railways are making steady progress in this country. The line at Portrush (Ireland) has now been opened twelve months, and has proved so great an attraction that the number of visitors to the Giant's Causeway has been increased tenfold. The line runs through very pretty coast scenery, but is certainly most trying to work, being a succession of heavy gradients and sharp curves, with practically no level ground for the whole six miles. The turbines answer admirably as the source of power; and the River Rush never fails in the dryest seasons. At Newry, a town midway between Belfast and Dublin, another electric railway is being constructed by the Bessbrook Spinning Company, the length of which will be about three miles. Two gangs of men are busily engaged in completing the earth works, bridges, &c., for the platelayers; and the rails have been laid for a considerable distance along the line from the Edward-street terminus. As soon as the rails are laid, Dr. Hopkinson, for the firm of Siemens Brothers, London, will commence the work of erecting the electrical machinery, &c., which will be placed in an old flour mill situate in Millwall, about midway between Bessbrook and Newry. It is believed that the Lord-Lieutenant will visit Newry on the occasion of the opening ceremony, which is expected to take place early next year. Active preparations are also being made to open a system of electrical tramways at Blackpool, which, in anticipation at least, are to surpass everything hitherto attempted; and it is hoped that the work will be completed early in the spring. A deputation of the local authorities of Blackpool recently visited the Brighton Electric Railway. For electric railways at the Novelties Exhibition next year no less than three distinct applications to exhibit have been made; but the limited space available will doubtless prevent their being granted. The Brighton Electrical Railway—it now being the height of the fashionable season—is still crowded for several hours daily, and arrangements are being made to run extra cars, passing on a loop half-way along the line.

LIGHTING OF THE "UMBRIA."—The electrical plant erected on this steamer by Messrs. J. D. F. Andrews and Co., of Glasgow, is probably the largest application of the electric light to a vessel that has yet been attempted. Every detail of the arrangement was carefully studied by Mr. Andrews, who has supplied all the latest improvements in his patented apparatus and specially designed fittings. These were considered generally to form together a perfect success in the matter of ship electric lighting by a large number of visitors who were invited to inspect the vessel previous to starting on her first voyage. There are ninety lights distributed in the engine room, stoke holes, &c., the leads being covered with india rubber and a special composition for resisting sea water, sheathed over all with iron wire, as a substitute for the tube generally used in engine rooms. The engine room lights are divided into two circuits, each with a separate switch; and each stoke hole is also on a separate circuit. The dynamos are connected to the main switch board on the bulk head, close to the engines; and to this switch board are brought the six main circuits which supply the vessel. The six circuits are numbered 1 to 6, starting from the stern, the first circuit supplying the night system, in which there are about two hundred lights including those in the engine room and stoke holes. No. 2 circuit lights the aft portion of the ship; No. 3, midships; Nos. 4 and 5, the main saloon, ladies' saloon, music room, &c.; and No. 6 all lamps forward of the saloon. Each of the main leads is carried to a group of switches at the junction of the main and branch leads, each switch controlling a group of about thirty lights. A simple switch, consisting of a screw, severing connection with the lamp from the ship, which is used as the return, is attached to each lamp; and these switches are under the control of the steward. There are altogether a hundred and three lamps in the main dining saloon, of which eighty-four are hung over the tables in 3-light pendants about 2ft. 6in. from the ceiling. The remainder of the lamps are in small brackets and pendants for giving light over the side seats. The music room, which is over the saloon, has seventeen lamps round the walls and over the piano and organ, while the smoke room is lighted by seventeen lamps, and the remainder are distributed about the ship, a hundred and seventy-two being in the state rooms. The time occupied in the installation did not greatly exceed two months.

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THE STEAM ENGINE INDICATOR.—I.

BY AMICE.

The steam engine has now become one of the most important of the machines placed under the care and control of the electrical engineer. It is therefore necessary that electricians should be thoroughly acquainted with all that pertains to the power of this essential motor. With this view, and in response to the wishes of numerous contributors, we recently published a series of articles on dynamometers, and these were so well received that we propose now to deal with the indicator and its uses in a similar manner.

The indicator may be looked upon as a mirror which shows us what is going on in the cylinder of a steam engine, both qualitatively and quantitatively. It is of course equally applicable for the same purpose to any other form of gas or fluid pressure motor. We shall, however, except where specially stated, speak generally of the steam engine.

Like almost all the essentials of the steam engine, the indicator was invented by Watt. He designed it for ascertaining the work done by the steam on a steam engine piston, and although in the hands of modern investigators, and with the aid of thermo-dynamics, it has performed most important services other than that of determining the dynamic value of the work done by steam, it is still most largely used for that more simple purpose.

The work done by a steam engine depends on the velocity of its piston and the pressure by virtue of which it acquires and maintains that velocity, these elements being usually expressed in feet per minute and pounds per square inch. That is to say, in foot pounds per minute. Of these elements the indicator diagram shows primarily one—namely, the pressure, and its function is especially to show the variations in this pressure due to expansion and to other causes of change of pressure during the stroke of the piston, and therefore to show variation of pressure through a distance. If the pressure in the cylinder were uniform throughout the stroke, the indicator diagram would not be required as an exponent of pressure, but it would still be required in some part of the history of every engine, for the purpose of showing whether in any or in what parts of the stroke variation occurred, if at all.

It is necessary here to say a few words on what is meant by work, and how this can be graphically represented. There must be a clear understanding of the connection between the indicator diagram and the indicated work. It must be seen that the indicator diagram only represents graphically the pressure acting on the piston of a steam engine during one stroke. It thus represents pressure and distance, throughout which the pressure acts, and therefore work done; but it does not show at what rate that work was done, and, therefore, not horse-power, inasmuch as the latter is expression for rate of doing work. That is to say, one term in the element, velocity, namely, time, has to be supplied. The diagram shows that pressure acted on the piston throughout the length of a stroke, but whether a century of years or only a second of time were occupied in performing this stroke it does not show. In either case the amount of work done would be the same,* but if it were only accomplished in the century, it would be useless for practical purposes. Thus, to use Professor Tait's definition, "the horse-power of an agent, or the amount of work done by an agent in each second, is the product of the force into the average velocity of the agent." If an agent, as an engine, raises 1,000lbs. through 10ft., it does 1,000 × 10 or 10,000 foot pounds of work, but the power of that engine will depend upon the time it takes to do that work, or its rate of doing work, and the horse-power is the power of doing 33,000 foot pounds of work in a minute, or 550 foot pounds per second.

Of the power of the animal whose capacity for work provides this unit, everyone has a natural conception. The horse is so universally employed for doing work that every man acquires insensibly a notion of the amount of work one or a number will do. Previous to the introduction of the steam engine horses were used to do the work subsequently done by that agent. Watt therefore set to work to find a numerical value for the work done by a good horse in a unit of time, and found it to equal 33,000lbs. raised 1 foot in 1 minute.

A graphic representation of the work done by steam on the piston of a steam engine would, if the steam were admitted at full pressure throughout the stroke of that piston, be afforded by a simple rectangular parallelogram. It would be thus

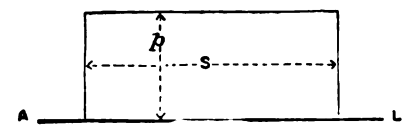

FIG. 1.

in the case of a high pressure non-condensing engine; while in a condensing engine of similar length of stroke and using the same pressure of steam it would be thus

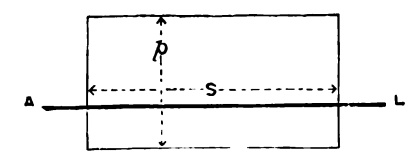

FIG. 2.

In both these diagrams S represents the stroke of the piston and p the pressure acting upon it. The line A – L represents what is, with the high pressure non-condensing engine, the line of no pressure, or what in reality represents the pressure of the atmosphere. The whole of the diagram is formed by steam at a pressure above that of the atmosphere. In the condensing engine it also represents the atmospheric pressure, that part of the diagram which is below that line representing the proportion of the pressure of the atmosphere which is made available as pressure acting on the piston by the formation of a vacuum in the condenser, this pressure being added to the steam pressure acting on the other side of the piston. The popular conception of the action of a vacuum is that of a power of suction which pulls the piston, but its action is due to the removal of atmospheric pressure from one side of the piston, so that the result is equivalent to making the pressure of the atmosphere available for doing work on the other side of the piston.

Before proceeding to the indicator we may define what we want it to show. Assume now that the line A – L in Fig. 3 is drawn on a piece of paper at such a level that it would as concerns non-condensing engines represent the line of no pressure. Although, as above explained, it would represent the pressure of the atmosphere, or say 15lbs. per square inch, this pressure is not available by the non-condensing engine, and is therefore to it a zero pressure, just as it is as respects a steam boiler, the zero point on the steam pressure gauge dial being the point at which the pointer stands when the gauge is subject to the atmospheric pressure. Turning

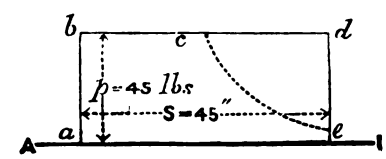

FIG. 3.

to Fig. 3, then, we will assume that the steam pressure from the boiler is such that it gives a pressure, p, of 45lbs. per square inch in the cylinder. Steam being admitted to the cylinder at the commencement of the stroke S of the piston, we may draw a line, $a\ b$, normal to A L, and of such a length that with a convenient scale it represents 45lbs. This, then, is the pressure per square inch acting on the piston at the commencement of the stroke. Assuming that the full pressure steam is admitted throughout the stroke, a line c, parallel with A L, and of a length $b\ d = S$, representing the whole stroke of

* This is not absolutely accurate, but for the velocities occurring in steam engine practice it is not necessary to consider the difference between the work done by the agent which, for instance, raises 1,000lbs. one foot in a second and that which raises 500lbs. in half the time through the same height.

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the piston, will show the pressure at every part of the stroke made in the direction $b\,d$ (in our case assumed uniform). The piston having reached the end, d, of its stroke, and exhaust being supposed to take place instantaneously, the line $d\,e$ may be drawn, indicating that the pressure at the end of the stroke has fallen to atmospheric pressure, or in this case to zero. The piston now commences the return stroke, and the pressure during this may be represented by the line $e\,a$. A parallelogram is thus completed which, if from an actual engine, would indicate that there was a uniform pressure throughout the stroke, and the indicated horse-power of an engine with a stroke, S, of 45″ = 3·75ft. and cylinder diameter, D, = 20·5in. in diameter, and having an area, A, = 330in., the engine making 50 revolutions, R, per minute, and being double-acting—that is, having steam pressure alternately on each side of the piston—would be

$$\frac{D^2\pi P(S\times 2)R}{33{,}000}=\frac{APR(S\times 2)}{33{,}000}=\frac{330\times 45\times 7{\cdot}50\times 50}{33{,}000}=168{\cdot}7\text{h.-p.}$$

It must here be stated that the full pressure of steam is never admitted throughout the whole stroke, but is cut off, according to circumstances and the kind of work done by the engine, at an earlier part of the stroke, as, for instance, one-half, when the pressure falls as shown by the curved dotted line. The diagram obtained under these circumstances is therefore not a parallelogram. The pressure acting on the piston is not constant. The vertical height of the line $a\,b$ varies at different parts of the distance S, and hence to find the work done during the passage of the piston through that distance, we must divide S into a number of equal intervals, and, assuming the pressure uniform throughout each of these, construct a parallelogram within each interval and the bounding pressure line. The work done is then represented by the combined area of the several small parallelograms. Thus, suppose S is divided into 10 equal parts by 9 intermediate lines. During the first four of these the height $a\,b$ represents, say, 100lbs.; the remaining six have mean heights which successively represent, say, 50lbs., 40lbs., 30lbs., 25lbs., 20lbs., and 15lbs. Now if S = 10ft., each interval being 1ft., we shall have for work done Mean pressure × 10ft.

$$=\frac{(100\times 4)+50+40+30+25+20+15\text{lbs}}{10}\times 10=58\text{lbs}\times 10\text{ft}$$

or the diagram has an area of 580, showing a mean pressure throughout the stroke of $\frac{580\text{lbs.}}{10}=58\text{lbs.}$, and this multiplied by the stroke, which, in our case is 10ft., represents 580 foot pounds. From numerous causes the diagram actually obtained is never square at the corners $d\,e$, and not often at a, but into these causes we shall enter at the proper time.

(TO BE CONTINUED.)

THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 431, VOL. XIII.)

Two Coils, with Cores, in Sequence.

From the already obtained solutions in the cases of open and closed coil circuit, we may deduce the solutions in many other cases of interest. Thus any number of similar coils with similar cores, having their cores charged in any manner to begin with, may be joined in sequence, and the resulting phenomena completely determined in terms of two solutions only. We start with a pair of similar coils. Let H_1 and H_2 be the strengths of magnetic force in the first and second core at distances r_1 and r_2 from their axes. When the coils are connected in circuit, the current must be the same in both; hence

$$H_1=H_2=4\pi N\Gamma \quad . \quad . \quad . \quad . \quad . \quad (101)$$

is the continuity condition, the boundary values of H_1 and H_2 being used, whilst Γ is the common coil current.

Let L and R be the coefficient of self-induction and the resistance of the circuit, both complete. The circuit may contain, besides the two coils mentioned, any number of other coils, either without cores, or with cores in which no current is permitted. The self-induction arising from their presence is included in L, so they may be dismissed altogether from consideration, and when we speak of the coils, we refer only to those with cores in which induced currents can flow. Let M be that part of L due to a single core—viz., $M=(2\pi Nc)^2l\mu$ (equation (6) putting M for L_1 for subsequent convenience). Then L − 2M is the coefficient of self-induction not counting the cores, and $-(L-2M)\dot{\Gamma}$ the induced E.M.F. to correspond. Also, the induced E.M.F. arising from the core induction is given by the third term with sign changed of either of equations (19), and is, owing to the coils and cores being alike, of the same form for both cores; so we get, when there is no impressed force in the circuit,

$$0=RH_1+(L-2M)\dot{H}_1+\frac{M\rho}{2\pi\mu c}(H'_1+H'_2),$$

for the equation of E.M.F. in the coil circuit. Or, putting $s=M\rho/2\pi\mu cR$,

$$0=H_1+\frac{L-2M}{R}\dot{H}_1+s(H'_1+H'_2), \quad . \quad . \quad (102)$$

A normal system is of the form

$$h_1=AJ_0(nr_1)e^{Dt}, \qquad h_2=BJ_0(nr_2)e^{Dt};$$

D being the same in both to make h_1 and h_2 subside at the same rate, whilst n is the same in both because the coils are alike. By (101), we therefore have (at the boundaries $r_1=r_2=c$)

$$AJ_0(nc)=BJ_0(nc), \quad . \quad . \quad . \quad . \quad . \quad (103)$$

which gives A = B, provided $J_0(nc)$ does not vanish. Putting the expressions for h_1 and h_2 in (102) we get

$$A\left\{J_0(nc)\left(1+\frac{L-2M}{R}D\right)-snJ_1(nc)\right\}=snBJ_1(nc) \quad (104);$$

and, eliminating A and B from (103) and (104) by cross multiplication, we arrive at the determinantal equation

$$J_0(nc)\left\{\left(1+\frac{L-2M}{R}D\right)J_0(nc)-2snJ_1(nc)\right\}=0 \quad . \quad (105),$$

from which we see that there are two series of roots, viz., those of $J_0(nc)=0$ and those of $\{\ldots\}=0$. These, for distinguishment, we shall call the first and the second set of roots. The first set is the same as we have when the coil circuit is interrupted, and the magnetic energy of the core is converted into heat in the core itself. The second set is the same as we have with a single coil and core, when the coil circuit is closed. (Examples 1 and 3.) With the second set of roots we have A = B, as shown above; with the first set, by using (104), since (103) fails, A = − B. In this last case there is no coil current accompanying the subsidence of the magnetic force normal system. Thus,

$$\left.\begin{aligned}H_1&=\sum_2 AJ_0(nr_1)e^{Dt}+\sum_1 BJ_0(nr_1)e^{Dt}\\ H_2&=\sum_2 AJ_0(nr_2)e^{Dt}-\sum_1 BJ_0(nr_2)e^{Dt}\end{aligned}\right\} \quad . \quad . \quad (106),$$

where the 1 and 2 under the Σ's indicate that the first or the second set of roots is employed.

Hence, by addition and subtraction, using the same value of r in both cases,

$$\tfrac{1}{2}(H_1+H_2)=\sum_2 AJ_0(nr)e^{Dt} \quad . \quad . \quad . \quad (107),$$

$$\tfrac{1}{2}(H_1-H_2)=\sum_1 BJ_0(nr)e^{Dt} \quad . \quad . \quad . \quad (108).$$

The expressions for A and B have been already given, in terms of the initial distributions, so we need not repeat them. Thus (81) gives B, when for H_0 there we write the initial value of $\frac{1}{2}(H_1-H_2)$, and this is a function of r, and (99) gives A, with corresponding alterations to suit the initial value of $\frac{1}{2}(H_1+H_2)$. Thus the theoretical solution is complete.

We may now consider the physical significance of the above, and how to practically apply it. In the first place, suppose the cores are charged to the same strength, and are then joined up so that they *add* their inductive E.M.F.'s in the coil circuit, the impressed forces being removed. Or, more simply, put

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them in series with a battery, and then remove the latter without breaking the circuit. From symmetry it is evident that the magnetic force subsides in the same manner in both cores, contributing equally to the circuit E.M.F., and that there is a current in the circuit. But as with the first set of roots there can be no coil current, it follows that the second set of roots, with the corresponding normal systems, must be alone in operation.

Next, starting with equal strengths, let the coils be joined so as to produce opposed E.M.F.'s in the coil circuit. These E.M.F.'s being equal, there can be no coil current. The boundary magnetic forces are zero, and the normal systems are those of the first set of roots only, the magnetic force in both cores subsiding in the same manner as if the circuit were interrupted.

Thirdly, let there be initially different strengths of magnetic force in the two cores. Decompose them thus:—

$$\left.\begin{aligned} H_1 &= \tfrac{1}{2}(H_1+H_2)+\tfrac{1}{2}(H_1-H_2) \\ H_2 &= \tfrac{1}{2}(H_1+H_2)-\tfrac{1}{2}(H_1-H_2) \end{aligned}\right\} \quad . \quad . \quad . \quad (109)$$

The portion $\frac{1}{2}(H_1+H_2)$ being the same in both cores, has the second set of normal systems only, thus giving us the solution (107); whilst the portion $\frac{1}{2}(H_1-H_2)$ being opposite in the two cores (as regards the direction of induced E.M.F. in the circuit) produces no current in the circuit, and has therefore the first set of normal systems, thus giving rise to the solution (108). Combining the thus obtained (107) and (108) we obtain the solution for each core by itself, expressed in equations (106).

We have in this deduction of (106) supposed H_1 and H_2 initially constant, but the reasoning plainly holds good when H_1 and H_2 are functions of r_1 and r_2, and are decomposed as in (109) into like and unlike auxiliary systems.

Now we have, in Fig. 3, given the curve of subsidence of magnetic force initially steady at the axis of a core, corresponding to the first set of roots of (105), and also the curves of subsidence at the axis and at the boundary for a particular case of the second set, viz.: coil of small depth, and a certain value of its time constant. Therefore from curves h_0h_0 and H_0H_0 (Fig. 3) (the last being with $2s=1$ in (105), and $a=c$), or a similar curve instead of H_0H_0 when $2s$ is not $=1$, we can draw the curves to suit the present problem. (Fig. 3 is unfortunately not quite so distinct as it might be, owing mainly to its reduction in scale from the original, which was drawn the same size as Fig. 2, to say nothing of the curves having got somewhat out of shape in the reduction. Also, H_2 should be H_a.)

If, at starting, the cores are equally charged, and the coils are joined so as to add the E.M.F.'s, the subsidence of magnetic force takes place similarly in both cores, being represented by H_aH_a at their boundaries (also the subsidence of the coil current) and by H_0H_0 at their axes.

But if they are connected so that the E.M.F.'s are opposed in the circuit, there is no coil current, and the subsidence in the cores is accelerated, being, at their axes, represented by h_0h_0.

Next, let one core only be charged, to begin with, and its coil then connected with the second coil with uncharged core, the battery being removed. The subsidence (axial) in the first core is got by taking the mean of H_0H_0 and h_0h_0 in Fig. 3.; *i.e.*, construct the curve whose ordinate for any value of the time is one half the sum of the ordinates of H_0H_0 and h_0h_0 at the same time. And the curve of magnetic force at the axis of the second core is got by constructing the curve whose ordinate is one half the difference in the ordinates of H_0H_0 and h_0h_0. The resulting curve, starting from zero, shows initial retardation, rises rapidly to a maximum, and falls thereafter slowly to zero again, as a portion of the energy originally in the first core is transmitted into the second, there to subside.

If both cores are charged to start with, but to different strengths, we must construct our curves by taking the ordinates of H_0H_0 and h_0h_0 in the proper proportions shown by the decomposition in (109), adding them for one core, subtracting for the other, to obtain the ordinates of the required curves.

The boundary force and the coil current curves may be got from the curve H_aH_a alone by merely altering its scale vertically, there being no coil current to correspond to h_0h_0. That is, directly the coils are connected, the current alters its strength to suit the mean initial force $\frac{1}{2}(H_1+H_2)$. For example, if the second core is uncharged the current drops suddenly to half strength.

(TO BE CONTINUED.)

CORRESPONDENCE.

BALL'S UNIPOLAR MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. H. A. Kent regarding the Ball Unipolar Dynamo, I noticed particularly the lights produced by the machine referred to. Whilst I had no opportunity of measuring the candle-power of the lights it was evident to the eye that they were much below the usual arc light of 2,000 candle-power. The dynamo was run at an enormously high rate of speed, driven by a very small belt, which travelled rapidly.

I saw no better results than would be produced by an ordinary Gramme machine, run at same speed. By the way, why should this machine be called unipolar? It has two poles and two armatures, one for each armature. It is difficult to see why this machine should be as efficient as a Gramme.—Yours, &c.,

A. KITSON.

125, North Seventh-street, Philadelphia, Pa.,
October 28, 1884.

10-LIGHT VICTORIA DYNAMO.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will any of your readers kindly inform me on the following points connected with the above machine:—

What is the resistance and size of wire wound on armature, and how many sections are there?

Also, resistance and size of wire wound on the field magnets, of which there are two pairs of poles. Please also give resistance and size of shunt wire.

What is the width of the ring armature?—Yours, &c.,

PHONO.

DANGERS TO ELECTRIC LIGHT WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In laying electric light leads under floors in old houses, I have been often afraid that rats or mice would attack the wires, and so cause a short circuit or leak.

To obviate this I have enclosed some of them in zinc tubing, and others I have simply painted over with Stockholm tar, after they were in position, which I believe will prevent rats from attacking them.

Can any of your readers, more particularly Mr. Moseley, who, I believe, has had great experience in this kind of work, tell me if he is aware of any cases of bell or other wires which have been attacked by rats, and if they can recommend any special means to guard against such risks?—Yours, &c.,

A. S. T. E. and E.

PROVISIONAL LICENSES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am anxious to get information relative to the cost of obtaining a license from the Board of Trade under the Electric Lighting Act. I shall therefore be glad if you will let me have the names of any local authorities or companies who have obtained licenses under the above Act.

In my case the license is required by the local authority for the district, so that there will be no opposition to such.—Yours, &c.

OHM.

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TELEGRAPHY AND TELEPHONY ON THE MIDLAND.

(FROM OUR OWN CORRESPONDENT.)

The Midland Railway is worked upon the absolute block system; while at the same time an interlocking system, by means of which the electric signals are electrically interlocked with the mechanical signals, is employed experimentally between the Trent and Derby stations on the London and Manchester main line. That is to say, for instance, a man at signal box B is unable to take off his signals so as to allow a train to proceed to A until he has obtained permission from A, or until A has given B the "All clear" signal on his block instrument. The chief merit of this interlocking system, which has been devised by Mr. W. E. Langdon, superintendent of the telegraph department, is its applicability to any existing form of block signals. The final action, which forms the "Train on line," or block signal, locks the instrument in that position; and the locking continues until it is released by the train in passing, or, in case it be desired, until the receipt of the *block* signal for the said train from the section in advance. The action of the signalman is in no way interfered with; but, should he attempt to pull over his signal lever, or to release the electrical block signal, when he ought not to do so, he would find it physically impossible. The contact arrangement in connection with the metals is self-adjustable, so that there is no need for readjustment when the sleepers are freshly packed, nor when the road becomes depressed from an excess of moisture. In either case, the contact adjusts itself to the position of the lever fixed to the rail, provision against submersion from floods being also provided for. With this system it is not possible for the signalman to give the "Clear" signal upon his starting or controlling signal, until he has obtained the "Clear" signal from the next block post towards which the train is about to proceed. Nor is it possible for the signalman to release the "Train on line" or *block* signal on his electrical instrument until the train has passed out of the section; and further, not until he has signalled such train on to the block post in advance, and received therefrom the *block* or "Train on line" signal for such train.

In several places where there are many lines and the traffic is heavy, as at Birmingham, Leeds, Bradford, Derby, and Peterborough, telephone circuits are used to assist the signalmen, and to aid in passing on the traffic, which at these places becomes sometimes rather congested. For instance, suppose a light engine or a train of empties was wanted to proceed from one point to another, between which there were several routes, the signalman would ascertain by telephone by which route the clearest passage was afforded. All telephone circuits have double wires, and when a number of telephone wires are hung together on the poles, each circuit is formed by a double wire.

At Derby, the head-quarters of the railway, is also the central telegraph station, the number of messages through which averages 5,500 a day, and sometimes amounts to 6,000, while the number of messages on the whole Midland system reaches 14,000, and sometimes 17,000, daily. When the traffic is impeded from any cause, the number of messages naturally increases; and this applies not only to the service but also to the private messages, which the Midland Company send on behalf of the Post Office Department. A system, in use on no other railway, has been introduced by Mr. Langdon, of making the receiving instruments give audible signals, so that the operator can write down the message without looking at the instrument; in this way a great saving of time is effected, so that fifty messages an hour can be received by one clerk, or 15 per cent. more than by a good operator with the ordinary needle instrument. The pulse of the telegraph is felt regularly every morning between 7:45 and 8 a.m., by testing all the more important circuits. The telephone is used for reporting, from the signal box to the telegraph office, the starting of trains on principal sections, and also any delay in starting trains on all others. A message is then telegraphed to all the signalmen along the line interested, which knowledge often permits them to send on a mineral train, which would otherwise be kept waiting.

The telegraph works, employing from fifty to sixty men, are very complete, consisting of battery and insulator, mechanics' and joiners' shops, paint and polishing shops, general stores, instrument room, and offices. The whole is lighted by sixty-five 20-candle Swan incandescent lamps, with a few Hammond arc lights, maintained by a Siemens compound-wound shunt dynamo, driven by a 4 horse-power nominal steam engine, which serves, during the day, to work the saws and lathes. The lamps are run in parallel arc, with safety fuzes made of very fine copper wire, the number of lamps depending on that of the lamps protected by the fuse.

ELECTRICAL BELL INDICATOR.

A cheap and simple form of apparatus to indicate that an electric bell is in working order, and that the circuit is in a proper condition, has long been a desideratum in the now almost universal system of bell work, and many attempts have been made to provide an apparatus that would fulfil this want. Mr. J. Kenneth D. Mackenzie has patented an instrument which it is thought will go far to supply this want. We now give some sketches of the apparatus, showing the general design. The principle of the invention is this, that iron when magnetised and demagnetised emits a sound

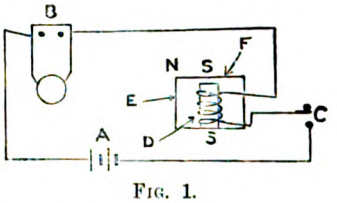

FIG. 1.

Fig. 1 shows the principle of the apparatus, in which A is a battery, B a bell, C an ordinary bell push, D an electro-magnet having one of its poles connected to the base of a small sheet iron box, E, having lid, F, of the same material. The electro-magnet D forms part of the bell circuit, and one of its poles being connected to the base of the box, as described, the lid becomes the polar extension of the magnet D.

When the circuit is joined at C a current flows along the line to the bell B, passing round the electro-magnet D, and back to the battery, and therefore the lid F and magnet D become magnetised and emit a sound. When the bell mechanism

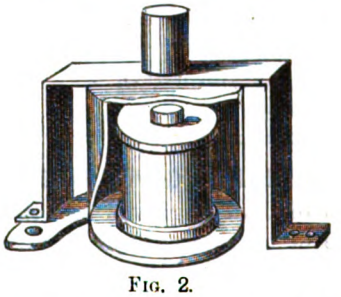

FIG. 2.

interrupts the circuit the magnet D and the lid F lose their magnetism and again emit a sound. This is the well-known so-called "Page effect" made use of practically. In practice the box is made small, not larger than 1in. in diameter, and with the ordinary allowance of battery power gives out a sound capable of being heard quite 20ft. away. The use of such an instrument is obvious, and for telephone circuits between subscriber and exchange, or between exchanges themselves, it will be of great importance, as it shows every time the call bell is run that the bell is actually ringing, and that therefore the circuit is in proper order.

On railways between signal boxes this little indicator would be of great importance, as the pointsman would be certain that the signal transmitted by him to the distant signal box had been received.

Fig. 2 shows the indicator as combined with an ordinary bell push, forming one complete instrument. As the indicator is *audible* it can be used in the dark as well as daylight, and is therefore more generally serviceable than a *visual* one would be.

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THE ELECTRICIAN.

VOLUME XIII.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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ACCUMULATOR.—*A letter awaits you.*
ZENO.—*Two letters await you.*

ELECTRIC LIGHTING FOR STEAMSHIPS.

The Institution of Civil Engineers has this week testified to the importance of the subject to which we adverted in our last week's leading article by devoting the first meeting of its winter session to the consideration of electric lighting applied to steamships. Mr. A. Jamieson's paper, which we hope shortly to be able to print in extenso, was an interesting and encouraging account of much that has already been undertaken in this line of business; and as he himself has been closely associated with the success of many of these installations on board ship no better authority could have been chosen by the Institution to furnish trustworthy information to its members on a subject of fast growing importance.

We say that Mr. Jamieson's paper and the discussion that followed it were encouraging, because the successes attending these efforts to provide a wholesome and agreeable light for passengers travelling by sea will directly tend to promote the extension of similar efforts on land. Electrical engineers like Mr. Jamieson have enjoyed the exceptional advantage of being free from the machinations of the company-mongers, and what is even of greater moment, from the trammels of the Electric Lighting Act. Nothing, perhaps, could better illustrate the superiority of an industry standing on its own merits and pushing its way by force of competitive good management. Contrasted with the condition of the same kind of business handicapped by grandmotherly legislation the progress of maritime electric lighting may be called a complete triumph; and as some of Mr. Chamberlain's handiwork has already received its severest check from the same quarter, we may be permitted to hope that this message from the region of shipping interests will prove equally efficacious in undoing more of what remains.

Mr. Jamieson's statistics of the progress of electric lighting on board steam vessels are a surprise even to us. It is now, apparently, considered an indispensable luxury that every newly built steamer shall be fitted with the new illuminant, and a great number of existing passenger vessels have already introduced it as a welcome improvement. Some idea of the extent to which this business has been carried may be gathered from the fact that one particular firm mentioned in the paper have within the past few years supplied no fewer than 616 engines for driving dynamos, 242 of which are for use on board men-of-war. For passenger steamships this is not the engine most favoured, and perhaps not the one most used, so that we may conclude that if we had complete statistics with regard to the rest, these figures would be considerably swollen. A singular omission we thought we noticed in respect to the supply of electric lighting appliances to vessels of war. France and Italy had taken a great number, especially the former country, and the rest of the navies of Europe and America had also obtained a fair number; but no mention was made of the British navy. The omission proves nothing, and of course we know that the electric light is employed on British ships of war; but it would have been interesting just now to have had fuller information on the subject.

Much useful information gained by practical experience was furnished by Mr. Jamieson as to the best means of leading the wires in iron built vessels, the kind of switches most suited for the peculiar exigencies of a sea voyage, and the most efficient form of safety fuse for guarding against overtaxing the lamps. A sensitive and trustworthy governor for the engine is also an indispensable adjunct at sea, more so than on land; and the lecturer has himself invented an appliance of the kind which to all appearance will answer the purpose admirably. Several other precautions and modifications of systems well adapted for solid earth have to be introduced into the arrangements for installing the electric light where the shifting and rolling caused by a heavy sea are to be guarded against. For full details of the provisions needful we must refer our readers to Mr. Jamieson's paper. But the important fact to be noted is that the difficulties attending such novel conditions have been satisfactorily overcome already, and that fresh installations are being called for every day.

The incandescent system is, of course, the one almost exclusively employed, though for certain purposes even on board passenger ships the arc light may be introduced with advantage. For search lights on men-of-war the latter is the only serviceable instrument; and Mr. Jamieson mentions instances where it has been employed also for fishing and salvage purposes as a submarine illuminator. We may also add that for signalling at sea the arc light, at all events if the steadiness of the carbons is not seriously affected in rough weather, will prove of great value, and we hope that our naval authorities have by this time enlisted it among the recognised methods of maritime telegraphy. But for general uses the incandescent lamp has won the largest, if not exactly the first, place at sea, as it has on land. The superiority of either kinds of lights,

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however, over oil or candle, for ship use, is obvious. The cleaning and replenishing of lamps is done away with, the danger of storing inflammable oils is avoided, and the temperature of the saloons and cabins is greatly reduced. We are not sure we can concur in Mr. Jamieson's claim for the electric light that the danger from matches and lighted tapers is lessened. This is a danger incurred anywhere and everywhere; and as you cannot light a cigar at an incandescent lamp, matches may be in greater demand among smokers than ever. The danger, however, is not from matches and tapers but from what they come in contact with; and it is a distinct gain in this respect to have got rid of that hoary offender "oil," whose crimes against our stomachs as well as against our safety are now happily past all forgiveness. On the whole, we have to congratulate the electrical world on the cheerful facts disclosed in Mr. Jamieson's paper, and to express our conviction at the commencement of this new volume that, notwithstanding the discouragement with which fortuitous circumstances have surrounded electric lighting, the time is not far distant when success, similar to that recorded of it at sea, will mark its progress in our social and industrial life on shore. Bad as is the account of the year's business of one great company, the report we publish in another column shows that the turning point has been passed, and that the concern can now be worked on profitable lines.

THE THEORY OF ALTERNATING CURRENTS.*

BY J. HOPKINSON, F.R.S.

In my lecture on electric lighting, delivered before the Institution of Civil Engineers last year, I considered the question of two alternate-current dynamo machines connected to the same circuit, but having no rigid mechanical connection between them, and I showed that if two such machines be coupled in series they will tend to nullify each other's effect; if parallel, to add their effects. The subject is one which already has practical importance and application, and may have much more in the future; it is also one suited for discussion, and upon which discussion is desirable. I therefore venture to bring before the society what I said in my lecture, some other ways of looking at the same subject, and an experimental verification, together with solutions of other problems requiring similar treatment.

The general explanation, amounting to proof so far as machines in series are concerned, is given in the following extract from my lecture:—

"There remains one point of great practical interest in connection with alternate-current machines—how will they behave when two or more are coupled together, to aid each other in doing the same work? With galvanic batteries we know very well how to couple them, either in parallel circuit or in series, so that they shall aid, and not oppose, the effects of each other; but with alternate current machines independently driven, it is not quite obvious what the result will be, for the polarity of each machine is constantly changing. Will two machines coupled together run independently of each other, or will one control the movement of the other in such wise that they settle down to conspire to produce the same effect, or will it be into mutual opposition? It is obvious that a great deal turns upon the answer to this question, for in the general distribution of electric light it will be desirable to be able to supply the system of conductors from which the consumers draw by separate machines, which can be thrown in and out at pleasure. Now, I know it is a common impression that alternate-current machines cannot be worked together, and that it is almost a necessity to have one enormous machine to supply all the consumers drawing from one system of conductors. Let us see how the matter stands. Consider two machines independently driven, so as to have approximately the same periodic time and the same electromotive force. If these two machines are to be worked together, they may be connected in one of two ways: they may be in parallel circuit with regard to the external conductor, as shown by the full line in Fig. 6—that is, their currents may be added algebraically and sent to the external circuit; or they may be coupled in series, as shown by the dotted line—that is, the whole current may pass successively through the two machines, and the electromotive force of the two machines may be added, instead of their currents. The latter case is simpler. Let us consider it first. I am going to show that if you couple two such alternate current machines in series, they will so control each other's phase as to nullify each other, and that you will get no effect from them;

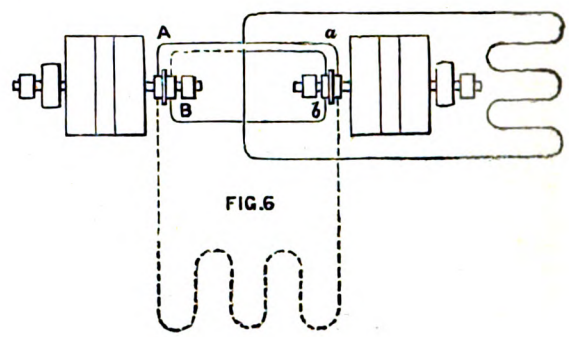

FIG.6

and, as a corollary from that, I am going to show that if you couple them in parallel circuit, they will work perfectly well together, and the currents they produce will be added; in fact, that you cannot drive alternate-current machines tandem, but that you may drive them as a pair, or, indeed, any number abreast. In diagram (Fig. 7) the horizontal line of abscissæ represents the time advancing from left to right; the full curves represent the electromotive forces of the two machines not supposed to be in the same phase. We want to see whether they will tend to get into the same phase or to get into opposite phases. Now, if the machines are coupled in series, the resultant electromotive force on the circuit will be the sum of the electromotive forces of the two machines. This resultant electromotive force is represented by the broken curve III; by what we have already seen in Formula IV., the phase of the current must lag behind the phase of the electromotive force, as is shown in the diagram by curve IV, thus —.—.—. Now, the work done in any machine is represented by the sum of the products of the currents and of

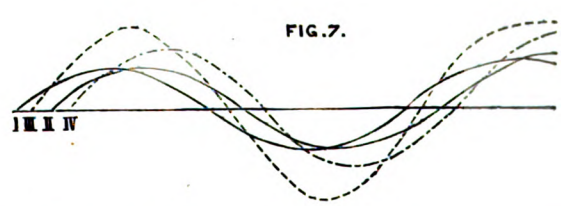

FIG.7.

the electromotive forces, and it is clear that as the phase of the current is more near to the plase of the lagging machine II than to that of the leading machine I, the lagging machine must do more work in producing electricity than the leading machine; consequently its velocity will be retarded, and its retardation will go on until the two machines settle down into exactly opposite phases, when no current will pass. The moral, therefore, is, do not attempt to couple two independently driven alternate-current machines in series. Now for the corollary. A B (Fig. 6) represent the two terminals of an alternate-current machine; *a b* the two terminals of another machine independently driven. A and *a* are connected together, and B and *b*. So regarded, the two machines are in series, and we have just proved that they will exactly oppose each other's effects—that is, when A is positive, *a* will be positive also; when A is negative, *a* is also negative. Now, connecting

* Paper read before the Society of Telegraph Engineers and Electricians on November 13th.

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A and *a* through the comparatively high resistance of the external circuit with B and *b*, the current passing through that circuit will not much disturb, if at all, the relations of the two machines. Hence, when A is positive, *a* will be positive, and when A is negative *a* will be negative also; precisely the condition required that the two machines may work together to send a current into the external circuit. You may therefore with confidence attempt to run alternate-current machines in parallel circuit for the purpose of producing any external effect. I might easily show that the same applies to a larger number; hence, there is no more difficulty in feeding a system of conductors from a number of alternate-current machines than there is in feeding it from a number of continuous-current machines. A little care only is required that the machine shall be thrown in when it has attained something like its proper velocity. A further corollary is that alternate currents with alternate-current machines as motors may theoretically be used for the transmission of power."*

Although the proof of this corollary regarding motors is similar to what we have just been going through, it may be instructive to give it. In the accompanying diagrams the full lines I and II represent the electromotive forces of the two machines (generator and receiver); the dotted line, curve III (. . . .), the resultant electromotive force; and the curve IV, the resulting current, each in terms of the time, as abscissæ.

FIG. 1.

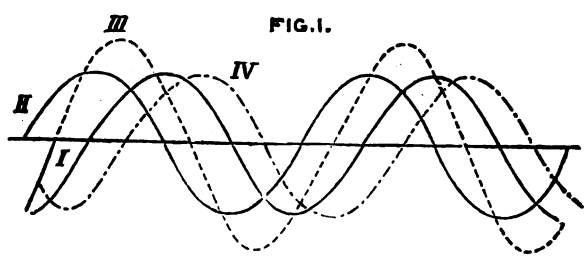
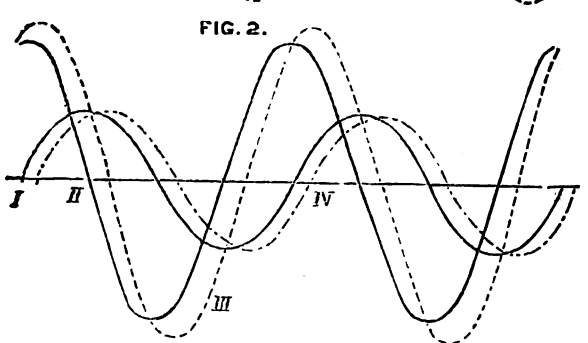


FIG. 2.



The only difference between the two diagrams is, that in Fig. 1 the two machines have equal electromotive forces, whilst in Fig. 2 *the receiving machine has double the electromotive force of the generator.*

In both figures the receiving machine lags behind the phase of direct opposition to the generator by one-quarter of a period, or something less. Now observe, the resultant electromotive force must be in phase behind the receiver, but in advance of the generator. Also observe, the current must be in phase behind the resultant electromotive force, and may be one-quarter of a period behind, provided only the self-induction be large enough compared with the resistance. The current will then be less than a quarter period behind the generator. This machine will do work upon the current, but the current will be more than a quarter period behind the receiving machine; therefore in the receiver the current does work upon the machine.

The subject is illustrated by the following problems. Of course any of them may be treated more generally by considering the machines as unequal, or by introducing other periodic terms, but I do not see that this would throw more light on the subject:—

I. *Two alternate-current machines, equal in all respects, are connected in series and independently driven at the same speed, to determine the current, &c., in each.*

Let γ be the coefficient of self-induction of each, r the resistance, x the current at time t, and $E \sin \frac{2\pi}{T}(t+\tau)$ and $E \sin \frac{2\mu}{T}(t-\tau)$ the electromotive forces. Then regarding the coefficient of self-induction as constant, which it is not exactly, and neglecting the effect of currents other than those in the copper wire, the equation of motion is

$$2\gamma x' + 2rx = E\left\{\sin.\frac{2\pi}{T}(t+\tau) + \sin.\frac{2\pi}{T}(t-\tau)\right\}$$

or

$$\gamma x' + rx = E \sin.\frac{2\pi t}{T}\cos.\frac{2\pi\tau}{T}$$

whence

$$x = \frac{E\cos.\frac{2\pi\tau}{T}}{r^2+\left(\frac{2\pi\gamma}{T}\right)^2}\left\{r\sin.\frac{2\pi t}{T} - \frac{2\pi\gamma}{T}\cos.\frac{2\pi t}{T}\right\}$$

Work done by the leading machine per second

$$= \frac{E^2\cos.\frac{2\pi\tau}{T}}{2\left\{r^2+\left(\frac{2\pi\gamma}{T}\right)^2\right\}} \cdot \left\{r\cos.\frac{2\pi\tau}{T} - \frac{2\pi\gamma}{T}\sin.\frac{2\pi\tau}{T}\right\}$$

$$= \frac{E^2}{4\left\{r^2+\left(\frac{2\pi\gamma}{T}\right)^2\right\}} \cdot \left\{r\left(1+\cos.\frac{4\pi\tau}{T}\right) - \frac{2\pi\gamma}{T}\sin.\frac{4\pi\tau}{T}\right\}$$

From this at once follows that the leading machine does least work, and will tend to increase its lead until $\tau = \frac{T}{4}$, when the two machines will neutralise each other, as already proved geometrically. *The leading machine may actually become a motor and do mechanical work, although its electromotive force is precisely equal to that of the following machine.*

Considering the important case when r is negligible, we have

$$x = -\frac{E\cos.\frac{2\pi\tau}{T}\cdot\cos.\frac{2\pi t}{T}}{\frac{2\pi\gamma}{T}}$$

$$\text{rate of working} = \frac{E^2\sin.\frac{4\pi\tau}{T}}{4\cdot\frac{2\pi\gamma}{T}}.$$

This is a maximum when $\tau = \frac{T}{8}$, and then it is equal to one-half of the maximum work which can be obtained from either machine when connected to a resistance only, which occurs when that resistance is $\frac{2\pi\gamma}{T}$; the current, however, is the same as when the maximum work is being done on resistance, and is $\frac{1}{\sqrt{2}}$ of the current the machine will give if short-circuited. The difference of potential between the two leads connecting the machines, whether $r=0$ or not, is $E\cos.\frac{2\pi t}{T}\sin.\frac{2\pi\tau}{T}$. If there be no work done on the receiving machine and $r=0$, $\tau=\frac{T}{4}$, and the amplitude of the difference of potential between the leads is E; if, on the other hand, the maximum work is being transmitted, the potential measured will be $\frac{1}{\sqrt{2}}$ of that observed when either machine is run on open circuit.

* "Of course, in applying these conclusions, it is necessary to remember that the machines only *tend* to control each other, and that the control of the motive power may be predominant, and *compel* the two or more machines to run at different speeds."

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II. *Two machines are coupled parallel and connected to an external circuit resistance* R.

Let $x_1 x_2$ be currents in the two machines. The external current will be $x_1 + x_2$, and consequently the difference of potential at the junction, R $(x_1 + x_2)$.

Let the electromotive forces of the two machines regarded in this case as connected parallel be E sin. $\frac{2\pi(t \pm \tau)}{T}$ and let the self-induction and resistance of each be $e\gamma$ and $2r$.

The equations of motion then are

$$2\gamma x'_1 + 2r x_1 = \text{E sin.} \frac{2\pi(t+\tau)}{T} - \text{R}(x_1 + x_2)$$

$$2\gamma x'_2 + 2r x_2 = \text{E sin.} \frac{2\pi(t-\tau)}{T} - \text{R}(x_1 + x_2)$$

whence

$$\gamma(x'_1 + x'_2) + (\text{R} + r)(x_1 + x_2) = \text{E sin.} \frac{2\pi t}{T} \cdot \text{cos.} \frac{2\pi\tau}{T}$$

and

$$\gamma(x'_1 - x'_2) + r(x_1 - x_2) = \text{E cos.} \frac{2\pi t}{T} \text{ sin.} \frac{2\pi\tau}{T}$$

Solving these,

$$x_1 + x_2 = \frac{\text{E cos.} \frac{2\pi\tau}{T}}{(r+\text{R})_2 + \left(\frac{2\pi\gamma}{T}\right)^2} \left\{ (r+\text{R}) \text{ sin.} \frac{2\pi t}{T} - \frac{2\pi\gamma}{T} \text{ cos.} \frac{2\pi t}{T} \right\}$$

$$x_1 - x_2 = \frac{\text{E sin.} \frac{2\pi\tau}{T}}{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2} \left\{ r \text{ cos.} \frac{2\pi t}{T} + \frac{2\pi\gamma}{T} \text{ sin.} \frac{2\pi t}{T} \right\}$$

electrical work done by the leading machine

$$= \tfrac{1}{2}\text{E sin.} \frac{2\pi(t+\tau)}{T} \left\{ x_1 + x_2 + (x_1 - x_2) \right\}$$

$$= \tfrac{1}{4} \frac{\text{E}^2}{(r+\text{R})^2 + \left(\frac{2\pi\gamma}{T}\right)^2} \left\{ (r+\text{R}) \text{ cos.}^2 \frac{2\pi\tau}{T} - \frac{2\pi\gamma}{T} \text{ sin.} \frac{2\pi\tau}{T} \text{ cos.} \frac{2\pi\tau}{T} \right\}$$

$$+ \tfrac{1}{4} \frac{\text{E}^2}{r^2 + \left(\frac{2\pi\gamma}{T}\right)^2} \left\{ r \text{ sin.}^2 \frac{2\pi\tau}{T} + \frac{2\pi\gamma}{T} \text{ sin.} \frac{2\pi\tau}{T} \text{ cos.} \frac{2\pi\tau}{T} \right\}$$

This expression shows that *the leading machine does most work in all cases.* Suppose r is small compared with R and $\frac{2\pi\gamma}{T}$, also that $\text{R} = \frac{2\pi\gamma}{T}$, we have the work done per second

$$= \frac{\text{E}^2}{8\text{R}} \left\{ \text{cos.}^2 \frac{2\pi\tau}{T} + \text{sin.} \frac{2\pi\tau}{T} \text{ cos.} \frac{2\pi\tau}{T} \right\}$$

make $\tau = -\frac{T}{8}$, and we see that the following machine will then do no work; when τ exceeds this, the following machine becomes a motor and absorbs electrical work.

(TO BE CONTINUED.)

MAGNESIUM BY ELECTROLYSIS.—Works have been put up at Charlottenburg, in Prussia, with a 100 horse-power engine driving four dynamos, for producing pure magnesium at a cheap rate by electro deposit. What has been accomplished leads to the hope that about 3cwt. of magnesium may be produced daily, at a cost not exceeding 10s. a pound.

ON THE INFLUENCE OF CENTRIFUGAL FORCE ON HIGH SPEED BELTING.

BY GISBERT KAPP.

The problem of getting a maximum of power and speed into a machine by means of belting is of considerable interest to the makers and users of dynamos. In comparison to its size a modern dynamo is an excellent apparatus for consuming power, and since its electrical output and commercial value both increase with the speed, it is advantageous to run it as fast as is mechanically possible or safe. In most cases the power is transmitted to the dynamo by a belt, the size of which ought to be determined not only with regard to the useful work done, but also with regard to strains due to its own weight. In ordinary belt or rope gear the latter may be neglected, because the speeds are so low that any small additional strain due to centrifugal force is amply covered by the usual margin of safety. Hence, the rules and tables generally found in hand books are deduced under the supposition that the belt has no weight. Another supposition is also made, viz., that the belt be perfectly flexible. In reality this is not the case; there is always some stiffness in the belt, which causes the side running towards the pulley to stand at a greater distance from the axle than the side running from the pulley. The difference in leverage between the two sides causes a certain loss of power, which is, however, very trifling with old belts put on moderately tight.

Of much greater importance is the effect of centrifugal force on high speed belting. Each portion of the belt as it comes round the pulley is subjected, by reason of its temporary circular motion, to a certain amount of centrifugal force, which tends to lift it off the face of the pulley. Whether separation does actually take place depends on the proportion between this force and the tension in the belt; but even if the belt is not completely lifted off the pulley there is a tendency to diminish its grip on it. Hence less power will be transmitted than corresponds theoretically to the strain in the belt. To counteract the influence of centrifugal force, it is therefore necessary to tighten the belt beyond what would suffice for the transmission of the power by means of a weightless belt, and thus an additional strain is put on to the belt, which in some cases may become so great that most of its tensile resistance is monopolised by it, leaving only a small margin for the transmission of the power. Under these circumstances the effect of centrifugal force must be taken into account, so that the total strain in the belt may be known; but this alone is not sufficient. Having determined the extent of an evil, we naturally inquire whether there be no remedy to lessen it, *i.e*, we desire to know how to design belts and pulleys so that the total strain shall be a minimum for each given case.

That a condition of minimum tension in the belt must always be possible will be evident from the following simple consideration:—

Imagine we have a dynamo which must be supplied with a certain amount of mechanical energy at a fixed number of revolutions. The width and thickness of the driving belt shall also be given, but the diameter of the pulley shall be left to the judgment of the engineer. If he chooses a pulley of small diameter, the strain in the belt due to the energy transmitted will be considerable, but that due to centrifugal force will be small. As he increases the diameter of the pulley he will lessen the former but augment the latter strain, and since the total strain is the sum of these two, it is reasonable to expect that there exists one definite diameter of pulley for which that sum becomes a minimum. It will be shown presently that this minimum is attained when the strain due to centrifugal force is exactly half that due to useful work transmitted.

Let in the annexed sketch—

R be the radius of the pulley in feet.
A B an infinitely small portion of the belt measured along the circumference.
$d\alpha$ the corresponding angle.
γ the weight of one foot of belting in pounds.
T and T_1 the strains in the belt at A and B respectively.

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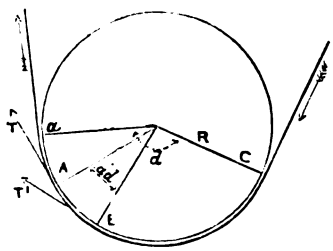
Suppose that the pulley is being driven by the belt, and that the movement takes place as indicated by the arrows; the greatest tension will then be in A and the least in B, whilst intermediate points of the belt will be strained less than A, and more than B, the strain in fact diminishing in some well-defined manner from A to B. The difference of strain in these two points equals the tangential driving force, and the difference of strain between any two intermediate points gives us that part of the driving force which is due to the corresponding portion of the belt. Thus the driving force exerted by the portion A B is

$$d\,T = T - T_1.$$

This force is transmitted to the face of the pulley by friction. Let ϕ be the coefficient of friction, then by multiplying the



pressure between pulley and belt by ϕ we obtain the force transmitted. If the belt had no weight the pressure exerted by the piece A B against the face of the pulley would evidently be

$$T \sin.\frac{d\,\alpha}{2} + T_1 \sin.\frac{d\,\alpha}{2},$$

or, since $d\,\alpha$ is an infinitely small angle and the difference between T and T_1 is also infinitely small,

$$T\,d\,\alpha.$$

But this pressure is partly taken off by the centrifugal force of the piece A B, the weight of which is

$$\gamma\,R\,d\,\alpha.$$

This weight revolving at the radius R n times a minute round the shaft produces a centrifugal force equal to

$$\cdot 000344\ \gamma\,R\,d\,\alpha\,R\,n^2,$$

or, if for simplicity we write ϵ instead of ·000344, the centrifugal force due to the infinitely small piece of belting A B is

$$\epsilon\,\gamma\,R^2\,n^2\,d\,\alpha.$$

This deducted from $T\,d\,\alpha$ and multiplied with ϕ gives the driving force of A B

$$d\,T = \phi\,(T - \epsilon\,\gamma\,R^2\,n^2)\,d\,\alpha;$$

which integrated between the limits $\alpha = o$ and $\alpha = \alpha$ gives the total tangential force transmitted to the pulley.

The term $\epsilon\,\gamma\,R^2\,n^2$ has a definite meaning; it is the centrifugal force which would be exerted by a piece of belt as long as the radius of the pulley, if the weight of this piece were concentrated in one point on the face of the pulley.

Write for brevity $\epsilon\,\gamma R^2\,n^2 = \beta$, then by integrating

$$d\,T = \phi\,(T - \beta)\,d\,\alpha$$

we obtain

$$\int \frac{d\,T}{T-\beta} = \phi\,\alpha$$

$$\text{log nat.}\left(\frac{T-\beta}{t-\beta}\right) = \phi\,\alpha$$

where α is the arc spanned by the belt, T and t the tensions on the tight and slack sides respectively.

It should be noted that the angle α is not to be introduced in degrees, but as the proportion which the arc spanned bears to the radius. For instance, if the belt spans half the pulley $\alpha = 3{\cdot}14$, if it spans one-third $\alpha = 2{\cdot}09$. Should the angle be given in degrees in the first instance the corresponding value of α is

$$\alpha = \text{degrees}\ \frac{6{\cdot}28}{360}.$$

Call F the circumferential force transmitted to the pulley, then we have

$$F = T - t,$$

and by a simple transformation of the above equation for $\phi\,\alpha$, we find the total strain in the tight side of the belt

$$T = \beta + F\,\frac{e^{\alpha\phi}}{e^{\alpha\phi} - 1}$$

where $e = 2{\cdot}718$. . . .

Every student of mechanics is familiar with the equation giving the strain in the driving side of a belt, if its weight can be neglected. This equation is

$$T_0 = F\,\frac{e^{\alpha\phi}}{e^{\alpha\phi} - 1}$$

and it stands in a most simple relation to the formula just found for a belt the weight of which must not be neglected.

$$T = T_0 + \beta$$

Hence the rule: *To find the strain on the driving side of a belt which runs at a high speed, calculate it first in the usual way by neglecting the weight of the belt, and then add to the force thus obtained the centrifugal force which would be exerted by a piece of belt as long as the radius of the pulley if the weight of this piece were concentrated in one point on the face of the pulley.*

Now comes the question whether it is worth while to make this calculation—that is to say, whether the influence of centrifugal force is so serious a matter after all. This can best be seen by an example. Say 20 horse-power has to be transmitted by a 6in. belt ¼in. thick on to an 8in. pulley running at 2,000 revolutions a minute, and say the belt spans 0·4 of the circumference. In this case F = 157·5lbs. In order to find T_0, it would be necessary to calculate the expression $\frac{e^{\alpha\phi}}{e^{\alpha\phi}-1}$, assuming a certain coefficient of friction, ϕ, and knowing the arc spanned.

This calculation can, however, be avoided by the use of tables which are found in every hand-book on the subject. Thus we find that for straps in ordinary working condition spanning 0·4 of the circumference the value given for the expression is

$$\frac{e^{\alpha\phi}}{e^{\alpha\phi}-1} = 1{\cdot}98$$

therefore $T_0 = 1{\cdot}98\,F$, that is $T_0 = 312$lb.

The weight of 4in. of this belting can be taken as 0·24lb. The corresponding centrifugal force is $\beta = 110$lb., consequently the total strain is

$$T = 312 + 110 = 422\text{lb.},$$

being at the rate of 281lb. per square inch of cross section. If it were desired to run the same pulley at 2,500 revolutions per minute, the centrifugal force would become

$$\beta = 172\text{lb.}$$

If the total strain should not be augmented through this increase of centrifugal force, we must make a corresponding reduction in the original strain T_0. That gives

$$T_0 = 250\text{lb. and } F = 126\text{lb.}$$

The corresponding horse-power at 2,500 revolutions is 20; that is, the same as before.

Although we cause the pulley to run 500 revolutions faster than in the former case, yet there is for the same strain in the belt no increase of horse-power obtained. If we drive the same pulley at 3,000 revolutions we have

$$\beta = 247\text{lb.} \qquad T_0 = 175\text{lb.} \qquad F = 98{\cdot}5\text{lb.},$$

and the horse-power transmitted only 18·8, *being actually less than at the lower speed.*

Take for another example the case of a wire rope driving a 4ft. sheave at 600 revolutions per minute.

Assume the rope to be one inch in circumference, and required to transmit 30 horse-power. What will be the maximum strain in it?

The circumferential resistance corresponding to the power required is F = 131·5lb.

The expression $\frac{e^{\alpha\phi}}{e^{\alpha\phi}-1}$ is for wire-rope gear, where the arc spanned by the rope is always equal to half the circumference, equal to 2; we have therefore $T_0 = 263$lbs.

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One foot of 1in. rope weighs 0·166lb., and the centrifugal force exerted by a piece of rope 2ft. long is

$$c = 80\text{lb.}$$

The total strain is therefore

$$T = 263 + 80 = 343\text{lb.}$$

If there were no centrifugal force, a strain of 350lb. in the rope would suffice to transmit 40 horse-power, whilst through the action of centrifugal force the same strain will only transmit 30 horse-power.

These examples will show that it is sometimes necessary to take the centrifugal force into account when designing high-speed belting, and then the question arises, what diameter of pulley will give the least total strain?

The circumferential force corresponding to horse-power is

$$F = \frac{\eta\,\text{H.P.}}{n\,R},$$

where we write for brevity η instead of 5,250, which coefficient gives F in pounds if the radius be given in feet.

Put $$\kappa = \frac{e^{a\phi}}{e^{a\phi} - 1},$$

then we have

$$\kappa F = T_0$$

and $$T = \kappa \frac{\eta\,\text{H.P.}}{n\,R} + \epsilon\gamma R^2 n^2$$

By forming $\frac{d\,T}{d\,R} = 0$ we find the condition for a minimum strain

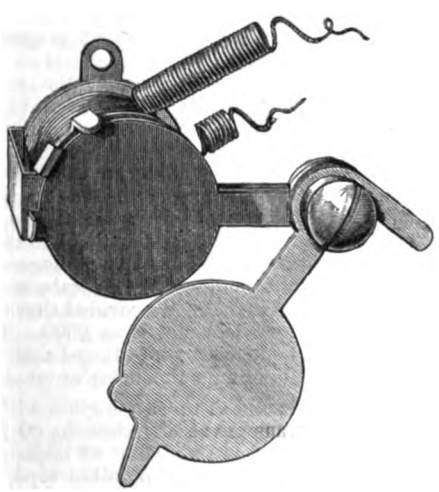
$$R = \frac{1}{n}\left(\frac{\kappa\eta\,\text{H.P.}}{2\epsilon\gamma}\right)^{\frac{1}{3}}$$

If the pulley has this radius the belt will be subjected to the least possible tension; if the pulley be smaller the belt will be strained more on account of the work transmitted; and if the pulley be larger the belt will also be subjected to a greater strain, but this will be principally due to an excess of centrifugal force.

(TO BE CONTINUED.)

THORPE'S SEMAPHORE INDICATOR.

This new electrical indicator has only one moving part; and all the parts are of metal, made by special machinery, and



interchangeable. While taking up but little space, it shows a large aperture, as will be seen by the annexed woodcut. The armature is under the semaphore arm, which immediately drops upon the current passing, thus showing the number, or the name of the room from which the call has been sent; these are then reset by a small bar, with pins, against which the semaphore drops. These instruments are sensitive in action and will work well with a chattering bell in the circuit; they are made for stock in all sizes up to 24 holes. The fronts are made in black mounts, with gilt edges, and with a plain glass in front, so that in case of breakage there is little to replace.

LIGHT FROM INCANDESCENT LAMPS.*

BY W. H. PREECE, F.R.S.

In a paper read before the Royal Society in 1883, I pointed out from experimental data that the light emitted by a glow lamp varied apparently as the sixth power of the current.

I have verified this law, not only by subsequent experiments of my own, but, which is much more satisfactory, by experiments of others. Professor Kittler, of Darmstadt, and Captain Abney have made, independently of each other, most careful and exhaustive measurements in this direction. I have tabulated and traced them out in curves, which I submit. They fully confirm the law that

$$L = k\,C^6,$$

but within limits, and that these limits embrace the ordinary range of a glow lamp when used for artificial illumination. As long as the resistance and the current vary uniformly together the law holds good; but as the state of incandescence is increased, a point is reached, varying with each kind of lamp, when the resistance ceases to diminish at the same rate, and eventually to increase. When this occurs the law is departed from, and the light emitted increases much faster than the sixth power of the current. The filament speedily breaks. The point of departure from the law indicates a point when a change of state occurs in the carbon filament. Disintegration probably sets in. This point ought to be determined for each kind of lamp, and it should never be allowed to be reached, for it is from this point that decay commences and rupture follows.

PROFESSOR JAMIESON ON SHIP LIGHTING.

At the first meeting of the session of the Institution of Civil Engineers, held on the 11th November, Sir J. W. Bazalgette, C.B., President, in the chair, the paper read was on "Electric Lighting for Steamships," by Andrew Jamieson, Assoc. M.I.C.E., F.R.S.E.

The author commenced with the statement that, although it was not more than three years since the first application of incandescent electric lighting to the general illumination of steamships, the advantages accruing therefrom had been so universally recognised, that more than one hundred and fifty ships had been fitted with it, and scarcely a man-of-war or a first-class passenger steamer now left the builder's hands without having it on board. This rapid success was mainly due to the following causes:—(1). Electric lighting on the incandescent system, when properly fitted, was more healthful, cooler, more easily handled, and more artistic than other systems of lighting; there was no smell, and no products of combustion to tarnish giltwork; it was more agreeable in every way than any of the older methods of illumination. (2). The danger from fire was less, as neither matches nor lighted tapers were required. (3). The daily cleaning and replenishing of lamps, as well as the keeping in store of highly inflammable oil, paraffin, or candles, could to a greater extent be dispensed with. (4). The expense of maintenance was not much in excess of that of the older methods of illumination (in some cases less), whilst the space occupied by the plant was not great, and its position near to, or in, the engine room caused no annoyance to passengers.

As the dynamo which furnished the electricity for feeding the incandescent lamps had to be driven at a uniform velocity, neither the ship's main engines, nor the donkey nor winch engines, were suitable for the purpose. The dynamo must have an engine for itself. It was, in most cases, necessary to place this special engine and the dynamo in such a position that the men on watch at the main engines could, with a minimum of trouble, also attend to the electric plant. This position, therefore, was naturally somewhere near the starting platform, and if possible on the ship's floors, so that undue vibration and noise might be avoided. Frequently a convenient recess could be provided, either immediately behind the main starting platform or opposite to the thrust block, just outside the screw-shaft tunnel door. Only in large installations would it pay to have on board an electrician solely to attend to the dynamo, its engine, and lamps. In such cases, a convenient and cool position was generally selected between decks, in the same compartment with, or in that next to, the refrigerating machinery, if such should be on board, so that one man might attend to both of these novel appliances.

Where practicable the axes of dynamos with large, heavy arma-

* A Paper read at the British Association at Montreal.

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tures should be placed fore and aft, to obviate as much as possible the effects of gyrostatic action, since the angular velocity due to rolling was greatest athwartship. The author here gave Sir William Thomson's formula and examples, to show the pressure produced on the dynamo bearings, under different circumstances, by gyrostatic action.

In selecting a dynamo it was necessary to determine whether or not it fulfilled certain requirements :—(1). It must develop electromotive force suitable for a certain lamp when driven at a certain definite speed. (2). It must be self-regulating ; that was, the electromotive force generated at the given speed must remain constant to within 5 per cent., whether working one lamp or more, or the full number of lamps. It was preferable to have a slight fall in electromotive force as the number of lamps was reduced. (3). There must be no undue emission of sparks at the commutator brushes. (4). When running light, or with less than the full number of lamps, there must be no undue heating of any of the parts. (5). The conductivity of the copper wire with which it was wound must not be less than 96 per cent. of pure copper. (6). The insulation-resistance of the armature and electromagnets should not be less than 10,000 ohms per volt generated at the required speed. The dynamo should be tested mechanically and electrically before being put on board ship, and afterwards, when fixed in position, by a final trial of not less than six hours' duration, with its own engine, and with all the lamps in circuit. There was considerable diversity of opinion regarding the limit of speed of a dynamo on board ship. As a consequence of the general desire for low speeds, most of the best forms of dynamos, the Siemens, the Edison, the Edison-Hopkinson, the Victoria, the Ferranti-Thomson, and the Pilsen-Schukert, had been specially modified for ship use, so as to produce the required electromotive force and current, at speeds varying from four hundred to six hundred and fifty revolutions per minute.

The success or failure of an installation on board ship depended as much upon the engine as upon the dynamo, and every care should be taken to procure one that needed the minimum of attention, and was not likely to break down. The engine should be capable of driving the dynamo during a voyage to Australia and back without a hitch and without requiring overhauling. The demand for such engines, more especially for those driving direct, had led to the production of a great variety, many of them excellent in workmanship and in detail. It was frequently necessary that the engine should be capable of doing its work when supplied with steam either from the main or from the donkey-boilers, so that the electric light might be available in port as well as at sea. This entailed capability for working under variable pressures, and thus the size of the engine must be adapted for the lower pressure. One of the most important adjuncts to the engine was its governor. It should be sufficiently sensitive and reliable in action to keep the engine within 5 per cent. of its normal speed, with a load varying 90 per cent., and a boiler pressure varying 10lb. per square inch. No mechanical governor could do this, and consequently a good electrical governor, which would automatically open and close the throttle-valve, in perfect synchronism with the load, or work to be done, and leave the valve in its last position until a change was made either in the load or in the steam-pressure, was greatly to be desired. The author showed how this problem had been solved by means of his electrical governor.

Then were detailed the different methods of driving dynamos on board ship by belts, ropes, gearing, direct-driving fast-speed engines, such as Brotherhood's, the Westinghouse, Messrs. Siemens' Frictional Drive, &c. The author explained the methods of fitting leading wires into vessels, instancing certain well-known cases by plans of the ss. "Adelaide" and the ss. "Arawa" ; and gave a practical rule which he had been in the habit of using for the dimensions of such wires. Insulation-resistance was too often neglected by electric light engineers. Amongst submarine telegraph engineers it was considered of vital importance to watch the insulation resistance with the most rigid accuracy, not only during the manufacture of a cable, but during its submersion and after it had been laid ; whereas, in the case of electric lighting, those charged with the fitting up of an installation very seldom thought of, or even knew how to take, insulation tests, either of the dynamo or of the leading wires. It was far from right to allow leads to be run up like bell-wires, without the slightest knowledge as to whether a flaw or a fault had crept in, and all engineers should insist upon rigid inspection, as well as thorough and searching tests, before an installation was passed. The insulation resistance standard need not be nearly so high as in the case of submarine cables; but nevertheless it did require to be several hundred times more than the copper resistance, otherwise a fault would soon develop, and short circuiting occur, under the combined influences of the electromotive force, and damp or wet. The dielectric should, therefore, in addition to being a good insulator, be thoroughly water-tight, and as little liable as possible to be affected by atmospheric changes. The author then gave a description of what he had found to be the best form of switches, fusible plugs, lamp-holders, lanterns, and globes. Finally he directed attention to the powerful search-lights used on board men-of-war, and to the novel application of arc lighting for salvage and fishing purposes.

The paper was illustrated by a large number of diagrams.

The announcement for the next meeting was as follows :—

Tuesday, November 18th, at 8 p.m. CIVIL ENGINEERS—Ordinary Meeting.—"Discussion on Electric Lighting for Steamships."

THE METROPOLITAN ASYLUMS BOARD.

[This is, we believe, the *first* specification for electric lighting open to public tender, and, if for no other reason, is historic ; but Dr. Hopkinson has probably herein laid the foundation for all future work of the kind.—ED. *E.*]

Specification for Lighting Machinery for Hospital Ships.

The contract is to include the furnishing, erection and running for a week of regular work of all that is required for the efficient lighting of the three hospital ships—"Atlas," "Endymion," and "Castalia," now moored in the River Thames at Long Reach, the buildings on shore, the pier, and the new road as far as Marsh-road, leading to Dartford. The tenders are to be in accordance with the following specification, but if any contractor desires to propose modifications of the specification for the purpose of employing types of machinery or patterns already in existence such modified tender will be considered. During its progress the work will be from time to time examined by the engineer appointed by the Board or by his representative, but such examination shall not in any way exonerate the contractor from the obligation to remedy any defects which may be found to exist when the machinery is put to work. All workmen employed by the contractor, whether on the ships or at the houses or buildings on shore, must be revaccinated, whether there are at the time patients on board the ships or not. The whole of the work must be completed before 31st January, 1885, unless further time is sanctioned in writing by the engineer or clerk of the Board, and the machinery must be run in regular work for a week by a representative of the contractor without developing any defect, during which time the engineer to the Board may make whatever tests he considers necessary. During this time the Board will provide ordinary labour and coals. In the event of the work not being completed in the time specified and run as above provided to the entire satisfaction of the engineer, the Board shall be at liberty without notice to call in any other person or persons to complete the work and may use all the materials and plant provided by the contractor, and may deduct the expense of doing so from the contract price agreed upon without prejudice to their other rights under their contract.

The managers will pay to the contractor as the works proceed such sums on account of the works as shall be stated in certificates in writing signed by the engineer within one month of the production by the contractor of the said certificates, such certificates to be given at the engineer's discretion at the rate of £75 per cent. on the contract value of the works done and fixed in position upon the said buildings up to the dates of such certificates, and the remainder, or such other sum as may be found due to the contractor on account of the works will be paid by the managers within one month after the date of the engineer's certificate that the works have been completed to his satisfaction, provided that no certificate on account shall be given for a less sum than £500. The decision of the engineer to be employed by the Board shall in all things relating to the contract be binding and conclusive on all parties.

Engines, &c.—To provide and fit up two engines with locomotive boilers, each capable when pressed of indicating 60 horse-power, but to work economically when indicating 40 horse-power. The engines and boilers to be of the semi-portable type, the engines compound condensing, with steam jacketed cylinder, automatic expansion gear, and a thoroughly efficient governor, air pump, condenser, feed pump or injector, and all necessary water pipes and chimney pipes for each engine, and the usual tools for working the engines to be included. The engines and dynamos are to be placed in an engine house provided, behind the present laundries, by the Metropolitan Asylums Board, who will also provide foundations, chimney stack, and flooring. If any contractor tendering prefer to employ other boilers than locomotive boilers, he may submit as an alternative one double-flued Lancashire boiler and one condensing compound engine capable of indicating 70 horse-power and of working economically when indicating 40 horse-power. In this case his tender must be accompanied by a particular speci-

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fication and drawings of the engine and boiler he proposes to use, and must include the flooring of the engine and boiler house with chequered iron plates, the foundations, and the flues and dampers from the boilers to the chimney stack.

Dynamos.—Two dynamos, compound wound for constant potential of 100 volts, to be supplied, driven respectively by link bands, supplied by the contractor, directly from the fly-wheel of each engine. Each dynamo to be capable of generating in continuous work 250 amperes without excessive heating of any part, and without undue sparking on the commutator. The dynamos must generate the above named current of 250 amperes at 100 volts from power applied by the strap not exceeding 44 horse-power. One spare armature fitting either dynamo, and three sets of spare brushes to be provided. The dynamos are to be carried on rails, provided and fitted by the contractor, and to be fitted with screw tightening gear, so that the belts may be tightened while the dynamos are running.

Lamps.—The lamps to be of 20 and 40 candle-power at 100 volts, and to require respectively not more than 0·62 and 1·24 ampere, and the contractor to guarantee an average life with fair usage of not less than 1,000 hours. The tender to include the supply and placing of 318 lamps of 20 candle-power and 26 of 40 candle-power, but more must be supplied, with their fittings, and connected if required, in accordance with a schedule of prices. Of the 318 20-candle lamps 287 are to be upon the ships and 31 on shore. Of the 26 40-candle lamps 9 are to in three lanterns as masthead lights, 11 on the pier, and 6 on the new road.

Fittings.—Each of the 344 lamps is to have a suitable plain brass bracket or other fitting. Lamp posts are to be provided for the lighting of the pier and new road, all subject to the approval of the engineer. Each of the three groups of masthead lights to be controlled by a single switch. In the stokehole of the "Atlas" there will be two lights on one switch, three lights on bridge from "Endymion" to "Castalia" on one switch, eight lights in each of the holds of the "Castalia" on one switch, entry port of "Castalia" two on one switch. On the pier nine lights are to be on one switch in the engine house and two on another switch in the engine house. In the mortuary on shore two lights on one switch, in the stable four lights on one switch. The six lights in the road to be on one switch in engine house, otherwise every lamp is to have a separate switch. Further a switch is to be provided for controlling together 120 of the cabin lights on the "Endymion," also switches or plugs for detaching at each end each of the four submarine cables, in case of accident, and switch or plugs for connecting either dynamo to the cables. Of the 20-candle lamps sixteen are to be provided with resistances which shall, when thrown into circuit, reduce the light from 20 candles to between 3 and 7 candles. The lamps are all to be placed as shall be indicated by the engineer in consultation by the medical officers of the ships.

Cables and Conductors.—The cables from the engine house to the ships are to be duplicated—that is, four in number—and laid some distance apart for security. The sectional area of copper in each shall not be less than 0·2 square inch. The conductivity of the copper not to be less than 96 per cent. of pure copper. The insulation to be gutta percha, jute yarn, and taped, and the cables to be protected by an iron sheathing. The tenders must contain a complete and detailed specification of cable proposed to be used. In ordinary work all four cables will be used, but a single cable will carry the whole current if accident should occur. For the purpose of this tender the length of each cable is to be taken as 200 yards, but if more or less is required allowance is to be made according to the appended schedule of prices. Both the positive and negative conductors are to be well insulated throughout, and the copper is not to be less than 96 per cent. the conductivity of pure copper. Suitable safety fuses or other cut-outs to be provided, so that the system of conductors exclusive of the cables shall conform to the following conditions when either pair of cables is in use and all the lights lighted. The current in no conductor when carrying its maximum normal load may exceed 1,000 amperes per square inch of section. If the current in any conductor shall exceed 2,000 amperes per square inch of section, such conductor shall be automatically cut out, whether such excess arise from an earth or a "short circuit." No cut-out shall give way with less than 20 per cent above its normal load. During the week's trial run the insulation of the negative or positive part of the whole system, including the cables, shall never be less than 10,000 ohms when running, and when the lamps are all detached the resistance between the two systems of conductors shall not be less than 10,000 ohms. The conductors are to be placed as far as possible out of reach, and not exposed to damp more than is absolutely necessary; on board the ships and in the buildings they are also to be covered with wooden battens, excepting in the case of the masthead lights.

Galvanometers.—Two galvanometers or equivalent instruments to be supplied by the contractor, one to measure the current of 250 amperes, the other a potential of 100 volts. Also suitable means for placing the current galvanometer in the circuit of either dynamo without stopping or breaking its circuit.

Fitting up at Long Reach.—The contractor shall put up the whole of the above described machinery and material and complete the same, so that every part shall be in a state to do its work in a satisfactory manner, finding all necessary material and labour, whether such necessary material and labour is particularly mentioned in this specification or not. He shall also put up any extra lamps, fittings, or wires, as may be required, within one month of the machinery being taken over, at the prices which he shall insert in the following schedule.

Schedule for Extras.

40-candle lamps, 20-candle lamps, brackets, switches for single lamps, wiring extra lamps, lamp posts, sheathed cable per yard.

PHYSICAL SOCIETY.—Nov. 8.

Professor Ayrton in the chair.

Mr. Kavargee was elected a member of the society.

Professor F. Guthrie read a paper on "Certain Phenomena Attending Mixture." In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first a mixture of water and ether is an example. When shaken up together they mix, heat is *evolved*, and a *diminution* of bulk takes place. If any excess of ether present is poured off, and the lower clear liquid *heated* in a sealed tube, it becomes turbid owing to the separation of the ether. This is accompanied by an *increase* of bulk and *absorption* of heat. Triethylamine and water and diethylamine and water are mixtures belonging to this class; the temperature of separation is a function of the ratio in which the two liquids are present. A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0°C. with *increase* of bulk and *absorption* of heat. Upon being *cooled* to about 17°C. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods are used. In the first, a number of mixtures of the same two liquids in different proportions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum there might be assumed to be no "dead matter" present. In the second method, which is more delicate, but more laborious, and which was used when the approximate combining proportion had been found by the first, the change of volume produced by mixture was noted; when this increment is a maximum the liquids are present in their combining proportions. These experiments gave very concordant and definite results. For example, that the molecular compound of ether and carbonic sulphide is represented by the formula $C_4 H_{10} O, 2 CS_2$, and that of chloroform and carbonic sulphide by $C H Cl_3, C S_2$. A striking confirmation of this view is afforded by the behaviour of the vapour tension of a mixture. The temperature being constant, if the vapour tension be plotted with the percentage of the more volatile liquid as abscissæ, the curve is, for a mixture of two liquids which have no chemical action upon one another as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The abscissæ indicates the molecular combination found by the previous experiment.

Dr. C. R. Alder Wright read a paper by himself and Mr. C. Thompson on "Voltaic and Thermo-voltaic Constants." In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential causes an increment (a) in the E.M.F. set up; (c) while an increment in the strength of the other solution causes a decrement (b) in the E.M.F. This law is now substantiated; it is, however, found that for dilute acids instead of metallic salts (b) may be negative. The authors also find that it is possible to represent the E.M.F. of a cell by the difference of two quantities, which they term the voltaic constants. These are quantities relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid; it is practically defined as the E.M.F. set up when opposed to a zinc plate in a solution of the corresponding zinc salt of the same molecular strength. The authors further conclude that the E.M.F. of a given combination usually *stands in no simple relationship to the chemical action taking place in the cell*, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electro-mechanical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid, and being constant for that metal and liquid *termed thermo-voltaic constants*. This thermo-voltaic action may act with or against the chemical action in

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producing E.M.F. In some cases, as in that of a cell composed of iron in ferrous sulphate and cadmium in cadmic sulphate solutions, the E.M.F. is against and greater than that produced by chemical action, consequently the cell works backwards with absorption of heat. At the close of the paper Professor Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermo-dynamics.

COMPANIES' MEETINGS.

Edison and Swan United Electric Light Company (Limited).

A general meeting of the shareholders in the two Companies which have been amalgamated under the above title was held on the 11th inst. at the Cannon-street Hotel, under the presidency of Mr. James Staats Forbes.

The CHAIRMAN, in opening the proceedings, said he would relieve the Secretary of the ordinary duty of reading the notice convening the meeting, the precise nature of which it was very necessary that they should know. It was not in any sense a legal meeting—it was more in the nature of an invitation on the part of the Directors of the new Company to the separate members of the old Companies, in order that they might learn the position of the United Company at the first annual occasion when it was possible to place it before them. The legal meeting of the United Company had already been held. The accounts had been audited and submitted, and a report had been drawn up; but the legality of the concern, so to speak, being vested for the time being in the hands of the Directors, they had thought it would be highly improper to take any decision on the report or the accounts. They therefore determined that the report and accounts should be sent to the respective shareholders of the separate Companies, and that they should be invited to attend that meeting that day substantially to hold a meeting of the United Company, with the drawback that any decision they might take there was not legally binding on any one.

A SHAREHOLDER: Then we are like ciphers.

The CHAIRMAN: Oh, no.

The SHAREHOLDER: Are the accounts to be passed to-day?

The CHAIRMAN: You will hear. The legal meeting had been adjourned pending the present meeting and the separate meetings of the two Companies, because after that meeting there was to be a Swan meeting, and he presumed that there would be an Edison meeting.

A SHAREHOLDER: Shall we have the power of being present, or any control over our own business?

The CHAIRMAN: The Directors, acting for you as trustees——

A SHAREHOLDER, interposing: Is that all?

The CHAIRMAN, continuing, said he thought it was a great deal. He could not himself give any better guarantee for the power the shareholders would have than that the Directors had invited them there that day to express their views. They wished to know by that meeting what the majority of the proprietors wished to have done, and if it were something which the constitution of the Company enabled the Directors to do, he supposed that they would do it. That being so, he would proceed exactly as if it were an ordinary meeting of the proprietors duly convened. The reason they were not called together as a meeting of the shareholders in the Edison and Swan Company was that it had been impossible hitherto, either on the part of the Swan Company or the Edison Company, to distribute to individual proprietors the shares in the new Company taken over *en bloc* by the two Companies. The reason the Edison Company had been unable to distribute their shares was that it was necessary first of all to liquidate their Company; and the reason the Swan Company had not been able to distribute their shares was that they had only parted with a portion of their business. Their shares in the United Company represented their English patents, but they had reserved for themselves their foreign patents; and what the Swan Company would have to do later on would be to see what machinery was necessary to cut up the present shares, so that one portion might represent the holding in that Company, and the other portion their separate interest in the foreign patents. There had been great difficulty in the cutting up of the shares, and this had increased the responsibility of the Directors, and until they could by proper and legal process distribute the shares to the shareholders in each Company they must bear that responsibility. Of course, as soon as that could be done it would be done, and then those present—some he supposed representing interests in the Swan Company and others interests in the Edison Company—would come to the meeting as to an ordinary meeting—they would come as shareholders in an ordinary company with all the powers which shareholders usually enjoyed. Practically, however, they were there that day with as much power as if they possessed legal powers to vote, as their decision would govern the acts of their trustees, the Directors. They were all familiar with the reasons for the amalgamation of the two Companies. The shareholders in the Swan Company had had the arguments placed fully before them, as, he presumed, had also been the case with the Edison shareholders. The two concerns were started independently of each other, each with a good name as a trade mark, and each with separate and distinct patents. The two Companies went on, as such companies usually did, "puffing" their wares, trying to make their own business, proclaiming each to be the right thing, and they had really commenced litigation as to the value of the patents, the Edison Company insisting that the Swan Company were infringers, the Swan Company insisting that the Edison Company were infringers. Fortunately some of the people connected with both of these Companies had gone through in other companies experience almost on all fours, and they knew what was to be expected from prolonged litigation. They therefore counselled not quarrelling or division, but a fusion of interests, and that principle was eventually adopted. Then there came a great practical difficulty. It was very easy to talk of combining two undertakings, but when they came to the question of values every one knew how buyer and seller differed in opinion. It was a difficult matter under ordinary circumstances, but in a case where the value was speculative, as in this instance, the difficulty was greatly increased. The Swan Company had paid a very large sum for their patents, and they were supposed to be invulnerable, and to lead to a business which by and by would be of enormous value. That was the theory of the Swan Company; and the Edison theory was precisely the same. After a great many suggestions, and after occupying the brains of certainly some not the least able men in London, or the least experienced, what was determined was this. It should be assumed that each of the Companies had acted *bona fide* in the purchase of their patents, and in the manner in which they had carried on their business; that all the patents should be put together and one strong Company formed, litigation avoided, and the business fostered and established. That was the principle they had determined to act upon, and having settled that principle all that they had to do was to take reasonable pains to see what money had been spent. The Directors, therefore—very wisely, he thought—put the matter into the hands of probably two of the most capable men in London—Mr. Welton, of the firm of Quilter, Ball, and Co., he representing the Swan Company; and Mr. Price, of the firm of Price, Waterhouse, and Co., he representing the Edison Company. It was on the report of these gentlemen, after a full and proper examination, that in the fused Company the respective portions of shares were allotted for distribution to the shareholders of the two Companies. Upon that being ascertained, an agreement was entered into, carrying out all the details of the fusion, determining in the most express language possible the conditions—monetary and otherwise—under which the affair was to be united, and that agreement was submitted, as it was legally bound to be, to separate meetings of both Companies. He remembered that he was rather verbose on that occasion in making it clear to the shareholders what they were doing in going into the union. They had now settled the shares which the partners were to have; and the Swan Company had taken a larger proportion than the Edison Company, because, wisely or unwisely, they had spent more money. Then the question arose, how was the machinery to be carried on? There were numberless points in connection with this question. They had not only to settle their relations as between themselves, but with persons outside. There were very large establishments—two sets of directors, two sets of officials, two sets of premises, and so on. The administration, by the articles, was submitted to delegates of four Directors, appointed by the Edison Company, and four appointed by the Swan Company, and as soon as that Board was formed they got to work, and they had done a great deal of useful work. Very much against his own will he had been induced for a time to fill the onerous position of Chairman of the Company. The Chairman of the Edison Company was Sir John Lubbock, who was known by every one to be a very distinguished man and of such high standing as to entitle him to the confidence of the outside world. Originally he had hoped that Sir John Lubbock would take the chairmanship of the United Company. That gentleman was Chairman of the Edison Company, and he (the speaker) was Chairman of the Swan Company; and although in the subdivision of the new shares the Swan Company had the larger proportion, he considered that he ought to sacrifice what might have followed as a kind of natural claim in the selection of directors and most willingly have yielded precedence to Sir John Lubbock. Unfortunately, however, family and other matters had made it impossible for Sir John to fill the position of Chairman, and he had himself been—he would say generous or weak enough to take upon himself the burden of the position for a year. The other Directors appointed were Lord Anson, Mr. Leyland, Mr. Arnold White, and Mr. Bidwell, who were appointed by the Edison Company; the Swan Company delegating himself, General Trevor, Mr. Villiers, and Mr. Batt. Those eight gentlemen from the time of the fusion had taken charge of the business. What they had had to do during the months which had elapsed had been to turn it all inside and out, to find out what there was in it, to eliminate the bad and keep the good, to fuse the establishments, and to bring down the accounts into something like tangible and reliable figures, and having done that, within the prescribed legal time to hold their first ordinary general meeting, which they had done, but which they had deferred taking any resolution on until they had had the opportunity of submitting it to them. The shareholders had before them the outcrop of all their efforts, and they also had for the first time a balance-sheet and statement of accounts of the United Company, which, whatever qualities it might have in the estimation of the shareholders, the Directors could submit as being reliable and verified figures, describing the position in which the Company now stood. In those figures, disagreeable as they were, there was nothing disagreeable which was in the least extenuated. Turning to the report of the Directors, he observed that it was the first annual report, and its object was to make the individual proprietors acquainted with the position of the United Company. As was stated, the wisdom of the amalgamation was confirmed by a special meeting of both companies, and the agreements were also in both cases unanimously approved. The statutory meeting of the new Company was held on the 29th of January last, at which the then position was explained pretty fully. The report explained what the position was at the precent time, and showed what the Directors had had to do; and the reason the financial result in the profit and loss account was not at all what they might have hoped for was indicated. Included in the capital of the Company (£353,478) was £85,695, representing 17,139 shares of £5 each, fully paid up, representing a corresponding number of fully paid-up shares in the former companies. The difference between the Swan

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Company and the Edison Company was this, the Swan Company had paid out and out a very large sum of money for their patents, as well as a considerable number of fully paid-up shares, while the Edison Company had purchased Mr. Edison's patents chiefly in virtue of a deferred payment. He had no hesitation in pronouncing that the Edison Company were much wiser than the Swan Company, because when one paid down a lump sum of money for an invention in its early stages, he in fact became the insurer of that invention—he made the inventor perfectly safe without taking any risk. That was what the Swan Company did. The Edison Company, however, paid Mr. Edison for his invention chiefly in this way: we will find the money and take the risk of developing the business, and if by means of your brains we make a successful business, when the interest on the capital which has been spent to make it a success has been covered, you shall come in for a large share of additional profit. In fact, one of the greatest inventors of modern times, backed by some very keen people who were not inventors but financiers, had thought so well of the business that they put themselves behind a 7 per cent. cumulative dividend over a very large sum of money for their consideration. They had this great faith in it, and he hoped that their faith would be justified, because when it was the gentleman who then addressed them would be able to point to such results that his task would be a very easy one. They had creditors to the extent of £19,937, and this brought up the whole capital and obligations of the Company to £373,000. On the other side they had endeavoured to analyse this amount as much as possible, because it was very desirable that gentlemen interested in the concern should know as much as the Directors. The thing, as it stood at present, was made up of two quansities, or factors. One was the indefinite, the other was the positive, and in the balance sheet they had endeavoured as far as they could to separate the indefinite from the positive. In doing this they had loaded the indefinite as far as they had thought prudent, and they had brought down the positive to the lowest limit. They might be sure that the liquid assets represented the least and not the most value. What did the affair cost—the purely speculative part of it? The cost of the patents, preliminary outlay, and other items not represented by money or tangible assets taken over was £174,000. He did not know whether the brains of Mr. Swan and of Mr. Edison, as concreted in these patents, were worth £174,000, but that was what they had cost them. Then there had been the expenditure in carrying the thing on. They had shares in the Manchester and District Edison Company—people who were to find the capital for exploiting the business; and when that capital received a certain amount of dividend the profits over and above were to be divided between themselves and the Edison Company. That asset was represented by £12,000 in deferred shares of the Manchester Company. Upon one hypothesis that asset might be worth £12,000, but they could not get that amount for it to-day. The fusion of the Swan and the Edison Companies had involved some delay in the confirmation of this agreement, because it was with the Edison Company pure and simple, and for the use of the Edison patents. The agreement had had to be modified, and the Manchester Company could now use the Swan patents—a privilege for which this Company had received value. As to the item of rental installations, plant, &c., he had before described what an installation was. The key of the position was the lamp. They might have the most charming engine, the most excellent machinery, the most admirable leads, but everything was subordinate to the lamp. The outlay on that part of the machinery was out of all proportion to the rest. The two Companies had entered into two classes of business. First of all, they made and sold lamps, and they undertook to erect installations and to light certain places at per annum—that amount not only producing the lamp but doing all the preliminary work. Both of the Companies were under contracts of that character. They had found it necessary, to form these installations, to spend £77,251. That was a very large sum, and there was this unsatisfactory element about it—that with their present knowledge he had no doubt that that outlay would have been materially less. They must remember what this business was. It was a business in a constant state of transition. The very machinery by which they began was being supplemented by other machinery more effective and less costly; and there was no doubt that that £77,251 would have to be written down a great deal unless they dealt with it as money or power-producing machinery. They had discovered that rental installations represented very bad business. The public, however, had to be educated, and taught that they could light up their houses, and theatres, and perhaps their streets in this fashion, but they would not believe it until they were shown. They therefore had to be shown, and that seemed to be the principle which dominated many of these installations. Where the installations were paid for at once the matter was different. There the risk was borne by the people who had the installations. The Swan Company, through Mr. Crompton, did the installation at the Law Courts. There there was a profit. The same remark applied with regard to installations on ships—they paid the cost of the fittings. With respect to the lamps, they were, as he had said, essential to both these descriptions of outlay, and this apparently was the most profitable part of the business at present. If the Company were to be wound up to-morrow, and the £77,241 had to be realised, it would not produce this amount by a very long way. The chief use of this expenditure had been to demonstrate to the world that the electric light was possible, and to identify with that demonstration the name of the Edison and Swan Company, and at the same time to warn the Edison and Swan Company that that was not a description of business they need be very anxious to obtain. He supposed that their policy in future would be to devote themselves to installations on the theory of being paid for the installation itself and not as rent, and to the manufacture and supply of lamps. The outlay on the factories had been a necessary expenditure, and it had left them possessed of factories of great productive capacity. Including the depreciation of £2,310, the balance showed a loss of £28,214. That was the end of the speculative portion of the assets. It meant this, that they had £300,000 in round figures locked up, represented by nothing very tangible—the great part of it certainly not very tangible,—some portion of it which would have a value by conversion and ultimate sale. All of the items of £77,000 odd to which he had referred were not lost, though a good deal of it was lost in the sense that it would not realise this amount if sold to-morrow. They had taken into this first sub-division all the risks they could. They had got for this £300,000 their patents, a first-rate manufactory, where a great many lamps were being produced; they had a trained staff, who were beginning to understand the work, and they had a Board who knew a good deal more to-day than they knew a year ago. The shareholders themselves would also have got a little wisdom, too—that was, that there was enormous risk in taking up patents of any kind and running all the risk of working them out for the benefit of the inventor. That lesson had been learnt in other things besides the Edison and Swan Company. He himself held a great many shares in the concern, and personally he was not disconcerted. They then came to the tangible assets, to which he referred *seriatim*. As to the plant and stock, it consisted of a great number of lamps, stores, materials, &c., valued at £23,900. He was assured by their admirable manager, Major Flood Page, and their accountant, that that £23,000 was a good deal within the value of the plant and stock if it had to be sold to-morrow. As to the item of debtors £32,000, he might say, as an evidence of whether these accounts were good or bad, that a great deal of the item had already been realised to the extent of twenty shillings in the pound. The cash in hand and at the bank was £4,000. That was the state of the case; and he believed he had exhausted the matter, subject to any cross-examination they might like to submit him to. The salient figures were £301,000 for patents, advertising, foundation charges, knowledge gained up to that moment, the rest being money invested in carrying on the business, which they believed might be carried on, with their present knowledge and under proper prudence, at a profit. They then came to the profit and loss account, which dealt with the year ended the 30th of June, 1884. Having gone through the various items he observed that the difference between the two sides was a loss, including depreciation, of £28,000. That was the outcrop of the year's business, and a very bad outcrop it was, if, as he had said before, there were not some rational grounds underlying it. It was a thoroughly fair and proper statement. As to the future of the concern [a Voice: "That is the point"], he was not particularly anxious to devote his time and money to develop a concern which he believed to be bad. As he had said before, he for one thought—and he believed he would have the concurrence of the Board in the remark—that the affair was not so bad that it ought to receive the *coup de grâce* on the statement which he had made to them. If it were so bad that every time they met they would show a loss of £28,000, he would say the sooner they put an end to the thing the better. He saw several gentlemen present who were very deeply interested in this Company, in money and reputation, and he knew of others similarly situated, who were absent, who had not lost confidence in the enterprise. He thought they had reasonable ground for the belief that some of the largest proprietors, notwithstanding the outcrop of the accounts now presented, did not take a despondent view. In fact he supposed it could be said that they had arrived at the condition of things which was called "turning the corner." They had tried to get some test of that by their experience of the working of the first quarter of the current year. When one had to write a report which was not altogether flattering or agreeable, one endeavoured to find a crumb of comfort to throw in. On page 3 of the report it was stated, "The books have been balanced to the 30th of September, as may be seen by the accounts which accompany this report, and the serious loss attending past work has disappeared." For what it was worth, that was a crumb of comfort. There was the balance sheet got out for the first three months of the current year, and at the bottom of it it showed that the balance of profit for the three months was £752. That figure multiplied by four represented £3,000, so that supposing the other three quarters of the year which had to elapse between September 30th, 1884, and the end of the financial year produced the same results, instead of showing a loss of £28,000 upon the year's business, there would be a profit of £3,000. That was the beginning of what they called turning the corner. They had paid the large sum which he had mentioned of £300,000 in the acquisition, and up to the present time the manifestation, of these patents. Of course the patents were being infringed. A number of clever people were playing what was called a "waiting game." They left the heat and burden of the day to be borne by others, at whose expense they afterwards shared the fortune of those first in the field. They had several of these persons now to deal with. They had had to resort to some proceedings to establish their patents. The two Companies would have had to resort to similar proceedings if they had not fused, the difference being that this Company had now both sets of patents, the one to help the other. Their chance was thus increased against outsiders, not as two to one, but enormously by the fusion of these interests; and they trusted that the Company would go on and establish the value of the patents held by them. If those patents were established they would have a property. They were not talking without knowledge in this matter, because the thing was on all fours with the telephone. There was an exactly parallel case—two inventors, Mr. Bell and Mr. Edison; two companies, the Bell and the Edison; two sets of litigants, and an amalgamation; and what had been the result of the fusion? After a very bad start, and having to fight the patents in every court of law, they had been confirmed, and the telephone in this country was not altogether an unsuccessful venture. It was very odd that the parties in the two instances should be in some respects the same. They had to beat the infringers; and the very same counsel who won in the one case were the very same counsel who protested against winning in the other. If so, well and good; and meanwhile, he was bound to say that the infringers, at their

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personal risk, were laying the foundation of the future business of the Company. Messrs. Woodhouse and Rawson, who were mentioned in the Directors' report, were, he said, the most active of the infringers. They were young men, and were very energetic in making business; and they were making and selling a great many lamps. The Court of Chancery had, however, made them give an undertaking that they would keep an account of the lamps, and if the Company succeeded in establishing the value of their patents Messrs. Woodhouse and Rawson would have "to cash up." If any one of the proprietors wished to wash his hands of the concern well and good, but the Directors were desirous that he should understand the position. They had to establish the patents and see if they could carry on the business at a profit. The Directors thought that the Company could do both, and their advice was to go on. They had to make up their minds what sort of business they were going to do; and, as far as the Board were concerned, they were not going to do any more speculative business. They knew all—or a good deal—about their lamp and about installations. They were not going to carry on installations on the rental system—they would sell, not rent. As to public installations and provisional orders, the Board of Trade had engaged themselves with the entire system, and had laid it down that the electric light was to be utilised in the public interest. They were very much afraid that it was going to run away with every one, and they felt that it was likely to become such a frightful monopoly that it must be tied up in every way. In fact, the poor public, not knowing how to take care of themselves, were to have all the support of the Board of Trade. Having got provisional orders they knew what they were worth—nothing; and the conclusion they had come to was that these provisional orders and the Electric Lighting Act was an act for making public lighting impossible, and they were not going to enter on any risk connected with it. They had stated their reasons for their decision to the President of the Board of Trade. There was, however, a great deal of business to be done at a profit. House-to-house lighting had exploded. Every man who was an inventor must be imaginative. When they came to predict about street lighting, and so forth, they had made the most awful blunders. He was not going to throw stones; but if the people who had found the money for these undertakings had not been quite so impressed with the imaginative qualities of the inventors they would not have paid so much for the inventions. This Company were not going to buy any more inventions in that way, or undertake the kind of work involved in street lighting or house-to-house lighting, or do any other lighting but that which paid. With that general principle before them their conviction was that, notwithstanding the disappointments, notwithstanding that their shares had no value, notwithstanding the difficulties which faced them, there was a reasonable ground for believing that, prudently managed, the concern might retrieve itself and present a very good future. A great deal of this would turn on establishing their patents, but setting that aside, on open business, with no patent at all, working with the strength of the names of Edison and Swan, and with the experience they had acquired, they ought to be able to do better than any competitor; and, assuming that the patents "vanished into thin air," he was not inclined to believe that this chestnut might not yet be taken out of the fire and a good business established. It was in that conviction that they suggested to every one concerned the propriety of re-forming the Board and going on on their reformed plan. According to the Articles of Association, the Board retired *en bloc;* and he had no doubt that they were all quite willing to retire if that were the desire of the shareholders. On the other hand, he supposed that, as honourable men, having assumed the responsibility of conducting the affair so far, they had enough self-respect left to be quite willing—some of them at great personal sacrifice of time and labour—to go on and see whether it was possible to put the thing on a sound basis and retrieve it. That was a point for the shareholders to decide. It was not a legal meeting for that purpose, but an intimation from the shareholders as to what they wished would receive the respectful attention of the Board. He had no resolution to propose, but he would be very glad to put it to them as a matter of form that the report and accounts be received. The moral effect of the verdict of the meeting would be exactly the same as the legal effect.

Viscount ANSON, on behalf of his colleagues of the Edison Company, said that he had listened to the Chairman's statement with great attention. He thoroughly acquiesced in all that the Chairman had said, both as to the causes which had led to the great loss they showed on the last year's trading, and also as to the possibility and even the probability of the concern being eventually turned into a somewhat profitable one. He thought it would be a great mistake if they now made up their minds to stop the Company altogether. If they could only hold their own for a short time, he believed that there was a possible and a probable chance of their doing well. He thought all the Edison shareholders must be fully aware that that Company had been put into liquidation. The Directors had done their best to bring about that result, and the entire affairs of that Company were now in the hands of the liquidator, who, he hoped, would shortly see his way to give them their shares in the United Company. He desired to state how thoroughly fair they had been received by their colleagues of the Swan Company.

Mr. KEMPSTER said that the Chairman had stated that he wished to know the feelings and wishes of the shareholders of the amalgamated company. He (the speaker) knew of no way of doing that except in some form of resolution. Therefore, at the request of some large holders in the capital of the Company, he took on himself to move the following resolution:—"That in the opinion of this meeting it is desirable that a committee of, say, seven shareholders, with power to add to their number, should be elected, who shall fully inform themselves as to the past working of each of the two Companies prior to their amalgamation, the present position of the United Company, and its prospects of successful working; also that such committee should confer with the Directors, and, if deemed necessary, report to the shareholders as to any steps considered by them advisable for placing the Company upon a sound commercial basis." He moved this resolution not at all in an unfriendly spirit towards the existing Board. He submitted with great respect that the present condition of the Company was such that the shareholders had a right to obtain independent information, and the only way of obtaining such information was from an independent source. He contended that they ought before now to have had the shares distributed among them.

Mr. SUDWORTH seconded the motion, observing that the installations at King's Cross, Mansion House, Bricklayers' Arms, and other places which were taken over by the Swan Company "were murdered and thrown away."

The CHAIRMAN stated that the experience of the Directors of the installations which they took over from Mr. Crompton did not justify the statement of the hon. shareholder. They did not pay either Mr. Crompton or the Company, and they were very bad bargains.

Mr. TIPPING objected most strongly to the appointment of the committee proposed.

Sir JOHN LUBBOCK, M.P., endorsed the view of Mr. Tipping. He added that he by no means took the hopeless view of the position of the Company which some appeared to do. It was, he argued, too early to judge of what the future of the Company would be until they saw the result of the actions against the infringers; but he was glad to hear the Chairman say that if those actions went against the Company he would not lose hope.

After some further discussion,

Mr. KEMPSTER, in deference to the feelings of the meeting, withdrew the resolution.

The CHAIRMAN said that if the resolution had been pressed the Directors would have opposed it tooth and nail. So far as regarded the issuing of the certificates, the Directors were most anxious to do so, and they would be issued as soon as practicable.

On the motion of Sir J. LUBBOCK a vote of thanks was passed to the Chairman and Directors, and the proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. NOV. 13.		BUSINESS DONE WEEK ENDING NOV. 13. Highest.	Lowest.
Anglo-American	32,	33	33	31½
Do. Preferred	55½,	56	56½	55
Do. Deferred	7⅜,	8½	8½	7½
Brazilian Submarine	10⅞,	11½	11½	10 15-16
Cuba	11,	11½	11⅝	—
Do. Preference	17,	18	—	—
Direct Spanish	3½,	4	3 9-16	—
Do. Preference	15,	15½	15	—
Direct United States Cable	9¾,	10⅛	10⅜	10
Eastern Telegraph	11⅜,	11⅝	11⅝	11⅜
Do. 6 per Cent. Preference	13⅜,	13⅞	13⅞	13⅜
Do. 5 per Cent. Debentures, 1899	104,	107	—	—
Eastern Extension	11⅞,	12⅛	12	11½
German Union	9½,	10½	—	—
Globe Telegraph and Trust	7,	7½	7 3-16	7
Do. Preference	12¾,	12⅞	12 11-16	12⅝
Great Northern	14,	14½	14 3-16	14½
Indo-European	32,	33	32	—
Reuter's	7½,	8	8	—
Submarine	175,	180	178	175
West India and Panama	⅜,	1½	15-16	—
Do. 1st Preference	7½,	7⅞	7 9-16	7 7-16
Western Brazilian	6⅜,	6⅝	6⅝	6 11-16
Western Union 7 per Cent. 1st Mortgage	120,	122	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	5-16,	7-16	—	—
Oriental	⅛,	⅜	—	—
United Telephone	11½,	12	12 1-16	11⅝

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	1 13-16	1⅝
Do. (fully paid)	3,	3½	3⅝	3⅜
Hammond Light (£3 15s. paid)	⅝,	¾	1 1-16	¾
Swan	—	—	—	—
Maxim-Weston	3-16,	5-16	¼	—

MISCELLANEOUS.

Telegraph Construction	34,	35	35	34⅜
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	23½	—

TRAFFIC RECEIPTS FOR OCTOBER, 1884.

COMPANIES.	Oct., 1884.	Oct., 1883.	Increase.	Decrease.
Cuba Submarine	2,200	2,744	—	544
Direct Spanish Telegraph	1,794	2,115	—	321
Eastern Extension	41,357	39,174	2,183	—
Eastern Telegraph	53,865	47,624	6,241	—
Great Northern	26,000	—	—	—
West Coast of America	4,065	—	—	—

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NOTES.

BRUSSELS UNIVERSITY.—Last week this establishment celebrated its fiftieth year of existence.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 14th Nov. amounted to £4,291.

PERIM.—In a note in our last issue, Perim was inadvertently stated to be off China. Most of our readers would know that Perim is an island in the mouth of the Red Sea.

ELECTRIC LIGHT AT MADRID.—The Madrid Electric Lighting Company has completed thirty-five installations, with 127 arc and 323 incandescent lamps in the city alone.

ELECTRIC LIGHT ON BOARD SHIP.—MM. Sautter, Lemonnier et Cie., of Paris, have undertaken the lighting of the Messageries Maritimes steamer "Océanien" with 150 Edison lamps.

ARTIFICIAL LIGHTING AND HEALTH.—The paper read by Mr. Crompton on this subject at the Healtheries Conference, together with the discussion thereon, has been issued in pamphlet form.

THE GROSVENOR GALLERY.—It will be seen from our advertisement columns that tenders are required for lighting these rooms by the electric light. The tenders are to be in by Saturday next, the 29th inst.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th Nov. are £2,123, as compared with £2,331 in the corresponding period of 1883.

ELECTRIC LIGHT IN SPINNING MILLS.—Last month, the Société d'Appareillage Electrique, of Geneva, installed forty-four 10-candle Edison lamps, maintained by an Edison dynamo, in the Lorze spinning mills, Canton of Zug.

ELECTRIC LIGHT AT LINLITHGOW.—On account of considerable increase in the cost of gas to the ratepayers, negotiations are going on with some electric light companies as to first cost and current expense of electric lighting.

ELECTRIC NEWS COMPANY.—Mr. W. J. Burnside and Mr. B. P. Daniels, the liquidators of the Electric News Telegraph Company, announce that all creditors of the company whose claims have been admitted will be paid in full.

ELECTRIC LIGHT AT GOODS STATIONS.—The goods station at Bromberg, in Germany, is illuminated by four arc lamps, and this installation will probably be followed by the application of the electric light to all the station buildings.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ending 14th Nov., 1884, were £3,393, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Tele graph Company.

HARTLEPOOL.—The Central Marine Engineering Works of West Hartlepool, having purchased from Messrs. Gray and Gladstone, of the same town, their Brush 16-light apparatus, have entrusted the erection of it to the Hammond Electric Light Company.

EARTHQUAKE AT CLITHEROE.—A severe shock of earthquake was felt at Clitheroe at ten minutes past 5 o'clock on Tuesday evening. A report like thunder is said to have been heard at the time of the shock, while a lurid glare was observed in the sky.

TORQUAY.—Negotiations are being carried on between the Torquay Improvement Committee and the United Telephone Company to establish a telephone exchange in Torquay. The company require 100 subscribers to start with, and the subscription is £12 per year.

ELECTRIC LIGHT IN PARIS.—The Paris Municipality has decided to prolong to the 18th May, 1885, the arrangement made with the Société Lyonnaise de Constructions Mécaniques et de Lumière Electrique for lighting the Place du Carrousel, at an expense of 16,912f. (£676).

EDISON'S INDIAN AND COLONIAL ELECTRIC COMPANY.—A petition for confirming a special resolution reducing the capital of this company from £250,000 to £117,500 has been presented to the High Court of Justice. The list of creditors is to be made out as for the 28th February, 1885.

ELECTRIC LIGHT IN LONDON.—The Streets Committee of the City of London have accepted the proposal of the Hammond Electric Light Company to undertake the lighting of streets in a district, and this company will have the right of private lighting in the district which they take up.

NEW CABLE IN ITALY.—The Italian Government has given notice that a submarine cable has been laid from Calato Point Island of Capri, in the Bay of Naples, across the Bocca Piccola, to the mainland. This supersedes the semaphore at Massa Lubrense, the station there being consequently discontinued.

CHARING CROSS AND WATERLOO ELECTRIC RAILWAY.—The promoters of this railway, which was sanctioned by Parliament in 1882 for the purpose of constructing an electric railway from Waterloo Station, passing under the River Thames to Northumberland-avenue, have decided to abandon the authorised railway, and to dissolve the company.

DEATH OF M. LATIGUE.—The Société Générale des Téléphones has sustained a great loss in the death of its director (general manager), M. Latigue, who was engaged for the greater portion of his life with the Northern Railway of France, but subsequently contributed in a large measure to endow his country with the first telephone systems.

JOINT FOR CONDUCTORS.—R. W. Kear, of Pottsville, Pennsylvania, connects the two wires by means of a socket furnished with a set screw. The action of turning the screw bends the ends of the wires and forces them to enter a small groove made for this purpose in the socket. This may be new in America, but it is certainly not new in England.

ELECTRIC LIGHT IN SWITZERLAND.—Besides the installation at Geneva, which we have already mentioned, the Société d'Appareillage Electrique, of that town, is about to provide the town of Aigle, in the Canton of Vaud, with a small central station for incandescent lighting, the motive power for which will be supplied by a canal which passes through the town.

BOSTON.—An electrical exhibition, to open Nov. 24 and close Jan. 3, will be held in the great building of the Massachusetts Charitable Mechanic Association. The exhibits will be classified under sections, thus: production of electricity, conductors, measurement, applications, terrestrial physics, historical apparatus, special novelties, and electrical literature, &c.

THE CREIL EXPERIMENTS.—The installation at Creil, 50 kilometres (31 miles) distant from Paris, is now terminated, as far as regards the work undertaken by the Northern Railway Company, while the receiving machines are being put

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down at Paris. The laying of the conductor is, however, not yet commenced, so it will be at least two months before the experiments can be begun.

INTENSE CURRENTS.—Drs. Brouardel and Gariel, who drew up a report on the death of two young men through contact with electric lighting conductors at the Tuileries, Paris, a few months ago, have applied for a subvention of 2,000fr., or £80, from the Paris Municipal College for studying the means of preventing danger to human life from electric currents of high tension.

INTERNATIONAL TELEPHONE COMPANY.—A meeting of shareholders in the Compagnie Internationale des Téléphones is called for 29th inst. at Brussels, to consider the report of the administrative council (board of directors) as to the modifications in the statutes (Articles of Association), and the reduction of the capital by means of purchase of shares, transformation of the company, or otherwise.

ELECTRIC CLOCK AT BARCELONA.—A rich banker of this city has placed in the Barcelona Exchange a magnificent clock, connected electrically with another clock, at the makers', a distance of 650 yards off, which serves as regulator. It is proposed to place both clocks in electrical communication with the Observatory of the Academia de Ciencias Naturales y Artes, where the meridian observations are made.

EDISON AND SWAN ELECTRIC LIGHT COMPANY.—The *Bulletin* of the Compagnie Internationale des Téléphones begins its notice of the meeting of the Edison and Swan Company as follows:—"We have so often had occasion to put on record the precarious situation of many English electric lighting companies, that we are glad now to be able to speak of a company the situation of which is more favourable."

SOCIETY OF TELEGRAPH ENGINEERS.—Through the courtesy of the Eastern and the Eastern Extension Telegraph Companies, the fact of Mr. Edward Davy's election as an honorary member of the Society of Telegraph Engineers and Electricians was communicated to him by wire, and we understand that by the same means Mr. Davy has been able to express to the Society his high appreciation of the honour thus conferred upon him.

CONGRESS AT THE SORBONNE.—At the Congress of Scientific Societies to be held next year at the Sorbonne, Paris, the mathematical, physical, chemical, and meteorological sections will deal, among other subjects, with the following:—Observations of earthquakes with instruments; sheet lightning and frequency of storms in the same day; the utility, as regards weather forecasts, of reports founded on magnetic and electrical observations.

SOCIETY OF TELEGRAPH ENGINEERS.—The next meeting will be held on Thursday, 27th inst., when the adjourned discussion will be taken on the following papers:—"On the Theory of Alternating Currents, particularly in reference to the Alternate-Current connected to the same Circuit," by J. Hopkinson, F.R.S., member; "An Account of Experiments with Alternate Current Machines," by Professor W. Grylls Adams, F.R.S., president.

THE TELEPHONE AND THE CHOLERA.—The Administrative Council of the Société des Téléphones has decided that messages respecting aid for those attacked by cholera in Paris, whether subscribers or not, shall be sent free of charge. The central offices are in telephonic communication with the Prefecture of Police and the twenty Mairies. At the last meeting of the Paris Municipal College, M. Lyon-Alemand urged that all the hospitals should be connected with the telephone system.

INVENTORIES, 1885.—The Society of Arts' *Journal* has been constituted the official record of the International Inventions Exhibition to be held next year, and will consequently publish all the official notices and other information. In consequence of a request from several foreign countries, the time for receiving foreign applications has been extended to 1st December, and in the case of the United States to the 31st December. It is stated that between 4,000 and 5,000 applications have come from Great Britain.

ANTI-BURGLAR ELECTRICITY.—Messrs. Eck, Callow, and Co., of Dean-street, Holborn, who recently fitted their electric fire alarms to the Natural History Museum, have brought out Harrison's Patent Burglar and Fire Alarm. This consists of an apparatus to be placed near the top of a building, and put in electrical connection with all accessible doors and windows. On one of these being opened, or even a pane of glass being smashed, a loud report is caused, and a bright light ignited, which lasts for a considerable period.

NATIONAL TELEPHONE COMPANY.—We are officially informed that the long pending dispute between the National Telephone Company and Messrs. D. and G. Graham has now been amicably settled. Arrangements have also been made whereby the Telephone Company now executes all the work in the Glasgow district, for which Messrs. D. and G. Graham have hitherto been the contractors, and consequently has now the whole of the construction and maintenance work under its own control throughout all its territory.

POST OFFICE EXTENSION.—The *City Press* says: "It is proposed to make an entire clearance of the buildings between the northern end of the new Post Office and the Money Order Office, thus absorbing nearly, if not quite, the whole of Bull and Mouth-street, with its private business houses and railway booking-offices, and some half-dozen houses in King Edward-street, while two other large buildings, one of a sacred and the other of a secular character, are also included in the general sweep. These are the French Protestant Church and the Queen's Hotel."

TELEGRAPHY AND TELEPHONY ON THE MIDLAND.—In the article bearing the above title which appeared in our last number, it is stated that a few Hammond arc lamps are used for lighting the telegraph works. This is incorrect; a few Hammond incandescent lamps only are interspersed with the Swans. The following statistics are interesting. The Midland Company employs, on its telegraph system, 15,100 miles of wire, 1,556 single-needle instruments, 3,890 block instruments, 2,500 block bells, 1,010 signal repeaters, 380 light repeaters, and 860 other instruments.

PET OF THE TELEGRAPHERS.—The *Chicago News* says that, a year ago, Lizzie Annandale, "the beautiful and vivacious contralto," of the Abbott Opera Company, got up a concert in Baltimore for the benefit of the telegraph operators engaged in the famous strike which then prevailed throughout the country, raising 2,500dols. (£500) by the venture; and since that time she has received the most flattering courtesies from the fraternity wherever she goes. "This simply goes to show," continues our contemporary, "that the telegraph operators are mighty well organised, and that they do not forget a kindness."

NEW APPLICATION (?) OF ELECTRIC LIGHT.—The Paris *Figaro* gravely informs its readers that an inventor has conceived the idea of transforming divers maritime routes into

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immense boulevards, illuminated by electric lighthouses, erected on quasi-islets, floating and incapable of being submerged, which are to be kept in communication with each other and the continents generally by submarine cables. Voyages will thus become mere maritime promenades, ships being guided on their course by a luminous "arc," produced by parabolic mirrors reflecting the rays of the sun or those of electric lights.

EDISON COMPANY, NEW YORK.—The selection of the board of trustees has not been altogether plain sailing. It is said that two lists were at first prepared—one by the existing board of trustees and the other by Mr. Edison, but a compromise has been reached and a combination list prepared, which is understood to be satisfactory to both sides. The list is said to be as follows:—Edward D. Adams, James H. Banker, Charles H. Coster, Eugene Crowell, C. E. Chinnock, Thomas A. Edison, W. L. Garrison, Edward H. Johnson, Francis R. Upton, Charles Batchelor, Spencer Trask, J. Hood Wright, and Erastus Wiman.

THE LATE POSTMASTER-GENERAL.—Mrs. Henry Fawcett and Philippa Fawcett desire to offer their most earnest thanks to all the officers, both male and female, engaged in the postal service throughout the country for the affectionate sympathy so spontaneously shown to them in their present great sorrow. It has been a solace to Mrs. Fawcett in her grief to know how deeply her dear husband's character and influence were valued throughout the department; and it will be a real source of consolation to her if she is able to believe that his influence is still felt, and that all those things that work for good in the department are permanently strengthened by her husband's work there.

BOOKS RECEIVED.—"Bell *v.* Drawbaugh," three vols., Mudge and Co., Boston; "The Disk, a Prophetic Reflection," by E. A. Robinson and G. A. Wall, Griffith, Farran, and Co.; "Exercises in Electrical and Magnetic Measurement," New Ed., by R. E. Day, M.A., Longmans, Green, and Co.; "Magneto-Electric and Dynamo-Electric Machines," by Dr. H. Schellen. Translated from the 3rd German Edition by N. S. Keith and P. Neymann, Ph.D., with additions by N. S. Keith. Vol. I., with 353 illustrations, D. Van Nostrand, New York. "Patents and Electricity," by R. G. Dubois, C. W. Brown, Washington, giving information about taking out patents in the States and notes upon electric light patents.

CONSERVATOIRE DES ARTS ET METIERS.—In giving the programme of lectures for the ensuing winter at this renowned Paris institution, we commented on the absence of a special course of instruction in electricity. We find, however, that Professor Becquerel's lectures on Applied Physics, given on Wednesdays and Saturdays, will deal with the general properties of electricity, applications of electricity to the arts, voltaic batteries, induction apparatus, dynamo-electric machines, transmission of power, electric lighting, electro-metallurgy, telegraphy, telephony and electric clockwork; while Professor Tresca's lectures on Applied Mechanics will include "other receivers" than steam and gas engines, and also the transmission of power to a distance.

PRIZES OFFERED BY THE SOCIETE D'ENCOURAGEMENT.—Among the competitions opened by the Société Nationale d'Encouragement pour l'Industrie Nationale, France, are three of special interest to electricians, and open to foreigners. But the communications must be sent in to the secretary, 44, Rue de Rennes, Paris, before the 1st January next. A prize of 3,000f. (£120) is offered for a method of transmitting to a long distance natural mechanical forces, the position of which prevents them from being turned to account directly. A prize of 1,000f. (£40) is offered for the construction of apparatus for transmitting to a distance an indication of the temperature of a heated chamber. A prize of 3,000f. (£120) is offered for strong and simple apparatus capable of announcing, safely, regularly, and automatically, the passage of a train, at any distance.

INFLUENCE OF BATTERY INSULATION.—Donald MacNab thus terminates an article on the above subject in *L'Electricien*: "What is manifest from all this, is the advantage of strong resistances of comparison of 1,000 megohms and over. These resistances are constructed in the following manner:—On an ebonite cylinder is traced a helicoidal groove, afterwards filled with a carbon paste. The contacts are obtained by means of pieces of metal encased in ebonite, which are flush with the bottom of the groove and in communication with the pole wires. Once the apparatus regulated—and this regulating cannot be otherwise than a delicate matter—it is coated with varnish to keep the carbon paste in the groove. Lastly, the apparatus is protected by a brass casing. These appliances are of incontestable utility, and are recommended by their cheapness, so that it is to be hoped that their use will become general in laboratories."

THE "GREAT EASTERN."—Instead of going to Gibraltar as a coal hulk, the "Great Eastern" is bound to the mouth of the Mississippi, to be used as a floating hotel. She will prove the attraction at New Orleans, and be an exhibition in herself. The fitting out of the "Leviathan" has commenced in real earnest. As far as possible, the work has been given to local contractors. It is estimated that it will take about six weeks to get her ready for her trip to the New World. Like Milford Haven, in which she is now peacefully anchored, her career so far has been anything but bright. But cheerful for twelve months (should she reach her destination in safety) it certainly will be. There will not only be joyous days for her, but also "revelry by night," with the "Stars and Stripes," instead of the "Union Jack," floating at her masthead. Milford Haven will, however, miss her—for over eight years their fates have been linked together.

THE NEW ORIENTAL BANK CORPORATION AND THE EASTERN TELEGRAPH COMPANY.—In the course of his remarks in addressing the statutory meeting of the shareholders of the New Oriental Bank Corporation, held on the 17th inst., Mr. W. W. Cargill (the chairman) spoke of the difficulties which had been met with in the formation of the bank through want of money, owing to the company not having been established through the assistance of any professional promoter. Mr. Rohde, however, had been fortunate in obtaining the aid and sympathy of many friends. But the most notable assistance had been that afforded by the chairman and the managing director, Mr. Pender and Sir James Anderson, of the Eastern Telegraph Company, who with the greatest kindness undertook to send all the telegraph messages required to and from the East in order to bring together the sentiments of people interested in the reconstruction of the bank. But for this assistance he did not see that Mr. Rohde could have carried out what he had done.

MORE BALLOON STEERING.—On 8th November two more ascents were made by Capt. Renard from Meudon, near Paris, with most successful results. About noon he rose from the departure lawn, and when clear of the surrounding heights set the propeller to work, which gradually increased the speed of the balloon. Meudon Viaduct was soon reached, and the Seine crossed below the Billancourt Bridge, when the balloon

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made for Longchamp, and came to a full stop a few hundred metres from the river. The screw was then stopped, and the speed due to the air current found to be eight kilometres, or five miles an hour. After five minutes' stoppage the screw was again started. The balloon described a half-circle, and went straight for the starting point, which was made with the greatest precision, after a 45 minutes' voyage, during which a speed of 23 kilometres, or 14 miles had been attained. After a rest of two hours the balloon was sent up again, and caused to make several evolutions in the neighbourhood of Chalais, turning to the right and left, stopping, starting again, and finally returning to the place whence it had departed.

Static Electricity for Children.—Our contemporary, *Kosmos*, gives the following directions for amusing the rising generation with electrical demonstrations which are quite as striking as rubbing a cat's back the wrong way. Heat a sheet of paper and pass it quickly between your trousers and the sleeve of your coat, or between the sleeve of the coat under the arm-pit, or even between the fingers, though this does not succeed so well. The paper will have become charged with electricity; but, as it is a bad conductor, the current accumulated on the surface will remain there. On holding the sheet by one corner and bringing the finger to the side, in a dark room, sparks will be seen, accompanied by a slight cracking noise. On placing gold leaf between two sheets of paper and charging them with electricity as before, the action of drawing the point of a pencil over the surface will cause a luminous line to appear in the dark. If two bands of paper about 8in. wide be placed together and rubbed only once in the manner above described, they will become so highly charged as to repel each other without it being possible to bring them together.

Conductivity of Saline Solutions.—Early this year M. Bouty communicated to the Paris *Académie* some general laws which he propounded as to the electrical conductibility of weak saline solutions. Professor Giuseppe Vicentini, observing their disagreement with the observations of Dr. Lenz, undertook a series of investigations by way of arriving at the truth; and the following are his conclusions, as recorded by the *Rivista Sientifico Industriale*:—(1) The electric conductivity of solutions of salts in water increases in direct ratio to their concentration, and this fact is true even for very diluted solutions; (2) The various salts experimented upon, even in very weak solutions and for the same degree of dilution, do not appear to have the same molecular conductibility; (3) The influence of the temperature on the electric conductivity of the solution is precisely the same for very diluted solutions of the various salts, and increases with the temperature; (4) In representing the electric conductibility of a very diluted saline solution at the temperature t, by the formula $C^t = C_0 (1 + \alpha + \beta t^2)$ the value of α approaches the value of the analogous coefficient, which gives the coefficient of friction of the water for a given temperature, while the coefficient β, much smaller than the coefficient of friction of the water, tends to increase with the weakness of the solution.

The Weston Lamp.—Since about the beginning of the present year the carbons of the Weston incandescent lamps have been made from gun cotton, by the following process:—The gun cotton, after being dissolved, is moulded into cakes, which are then cut into thin sheets. These are soaked in sulphide of ammonia, which removes the nitryl and converts the structure into pure cellulose. The sheets are then rolled to the thickness desired for the filaments, which are then cut out by dies in the zigzag form adopted for the standard (16-candle power) lamps, which form is claimed to give a more uniform illumination at all angles than the plain loop. The threads for the large (125 candle-power) lamps, however, are cut straight. The filaments are then packed in plumbago and baked several hours in a furnace. Having thus been carbonised they are treated by the Maxim process for correcting irregularities in the size and resistance. This, briefly, is as follows:—The filament is held by temporary clamps in circuit in a vacuum into which a little hydro-carbon vapour has been introduced. When the current is passed the hot filament decomposes the hydro-carbon vapour, and deposits the carbon on itself. Those places which are smallest and have the most resistance become the hottest, and thus receive the largest deposit, so that the resistance is made uniform throughout.—*Sanitary Engineer.*

Electric Light in Mines.—Three years ago, Siemens and Halske, of Berlin, installed two 3,000-candle arc lamps in an open working, 2,000ft. long, 1,000ft. wide, and over 300ft. deep, at the Mechernich mines, Rhenish Prussia, in which 300 men and twenty horses are constantly employed. The lamps were placed sufficiently high, above the steps in which the mine is worked, to be out of reach of stones projected by blasting; and the light is thrown down on the workings by powerful reflectors. As any interruption, even for short periods, such as those occupied in renewing the lamp carbons, would be dangerous, the whole plant is double, each lamp receiving its current from a D_2 dynamo. No hitch whatever has occurred; and the safety of the mines has been decidedly increased, while the cost shows a saving of about 4d. an hour in favour of the electric light. This satisfactory result obtained in the open workings led the company to introduce the light in the subterranean galleries, which are constantly widened out till they become 90ft. wide and 70ft. high, the length being sometimes 300ft. At first, arc lamps of 1,000 to 3,000 candle-power were used, with the positive carbon in the lower holder; but the light did not sufficiently penetrate the white smoke generated by the shot. As the smoke settles in ten minutes, however, it was thought advisable to wait this short space of time and use lamps of 350 candle-power, which proved thoroughly efficient. Ten of these are used with about 10,000ft. of lead cable, which permits of the lamps being removed when a shot is to be fired.

The Vulcanisation of Rubber.—For vulcanising india rubber there is generally employed a bath of sulphur and steam under pressure. According to the *Chronique Industrielle*, Messrs. De la Tour du Breuil Brothers have conceived the idea of substituting a concentrated solution of calcium chloride capable of furnishing a constant temperature of from 150 to 160 degrees. The advantages of this substitution are very important, and may be summed up as follows:—There is no modification required in the present apparatus existing in factories. The iron plate vats, not being exposed to burning, last much longer. The capital invested in the bath is insignificant compared with that required by the sulphur bath. Sulphur, in fact, costs in Paris about 200 francs per ton, while calcium chloride is but 80 francs. The daily consumption of the chloride, when the bath has once been prepared, is almost nothing, since this salt is fixed and indecomposable, while with sulphur there is a continual consumption, on account of its volatilisation and accidental combustion. As a consequence of the suppression of the vapours of sulphur and sulphurous acid in the works, the manufacture has no bad influence upon the health of the workmen. There is no danger of fire, and consequently the

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insurance rates are lower. The apparatus lasts longer, since the iron employed for locking the moulds no longer has sulphur to combine with and make it brittle. The consumption of fuel is greatly reduced (say about two-thirds), since the bath has a powerful calorific capacity, and the vats may be heated by an open fire. Finally, as the boiling is much gentler and more regular, it gives products of superior quality, and little or no waste, on account of the facility that exists of always keeping the bath at a temperature of between 150 and 155deg.

THE THUNDERSTORMS OF 1884.—The November issue of *Symons's Meteorological Magazine* deals fully with the year's thunderstorms. The summary is as follows:—"We are well aware that in these days it is not easy to induce persons to read through a long list of casualties such as we have at last concluded, but we can assure our readers that there are many cases extremely interesting and instructive. As our Government (unlike those of France and Germany) does nothing towards the registration of damage by lightning, we have made an effort in that direction this year. But it is utterly unreasonable to expect such work to be done by private effort, and we are certain that our list is very imperfect; as regards minor accidents, injury to trees, to sheep, and to cattle, it is probably less than half the truth. Doubtless further information might have been obtained from the Agricultural Insurance Companies; but the compilation of such a list is not our duty, and it ought to be done officially, as in other countries. However, we have done what time allowed; and the results are important, and probably unexpected. The final totals are large; 35 men killed and 91 injured is a sad beginning to the list, and one to which no money value can be assigned. But as regards the other items, we have tried to form an approximate estimate, a very wild one we admit, but one in which we have tried to keep the amounts low, and in which probably errors will neutralise each other. Leaving the people out of the calculation entirely, the damage recorded comes to nearly £10,000, and had all damage been reported, and proper records kept of the values, we have no doubt that it would be nearer £30,000 than £10,000." The remaining totals show 44 horses killed and 8 injured, 181 cattle killed and 14 injured, 239 sheep killed, also two dogs and three pigs. The trees struck numbered 82, while 14 stacks were destroyed and 18 others struck; also 20 churches, 112 houses, 10 cottages, 21 barns, 42 chimneys, and 11 factories more or less injured.

SOCIETY OF ARTS.—The first meeting of the 131st session of this society was held on Wednesday night at the hall in the Adelphi. The audience included Sir Frederick Abel, F.R.S., chairman of council, who presided; Lord Alfred Churchill; Sir Philip Cunliffe-Owen, C.B.; Sir Frederick Bramwell, F.R.S.; Sir Robert Rawlinson, C.B.; Captain Douglas Galton, C.B.; Professor Dewar; Mr. W. H. Preece, F.R.S., and Mr. J. M. Maclean. Sir Frederick Abel, in referring to the death of Sir William Siemens, went on to speak of the topics dealt with in his unfinished address, with which, had its writer lived, the last year's work of the society would have been begun. Prominent among these was the final settlement, by the Electrical Congress which met in Paris last April, of the standard of electrical resistance to be adopted for international use, as well as of other important matters relating to electrical units of measurement. The results obtained in different countries by applications of the various means of electrical measurement, which have already attained a high degree of perfection, are now expressed in what may be termed a universal language, the few words of which serve at the same time as monuments to the memory of some of the most illustrious pioneers in electrical science—Volta, Ohm, Ampère, Coulomb, Faraday, and Watt, the employment of the last name being a suggestion, now adopted, by Siemens himself. That electric lighting was really progessing in this country was shown by a reference to the successful work effected at the Health Exhibition, some statistics being given of the amount of power employed, its result in the light produced, and other similar points. As regards the experience gained from this extensive installation, Sir Frederick Abel believed it proved, as regards lamps, that there are now eight or nine really trustworthy makers, and as regards dynamo machines, that the occasional failures have been due quite as much to the mechanical accessories as to the machines themselves. Looking at the results of the year's experience, not only at South Kensington, but elsewhere, it appeared that while the practical difficulties attending the distribution of power for lighting up an extensive populous district from a large central station are much what they were when Sir William Siemens explained their nature two years ago, the working of small central stations has now for some time past been efficiently carried on in many parts of the kingdom. Further than this, it has been demonstrated that the working and proper control of an entirely self-contained electric light installation is within the powers of a domestic establishment, and that electricity could much surpass in efficiency, and perhaps cope in point of economy, with our usual domestic illuminating agents and appliances. A tendency to exaggerate the danger attending the introduction of electric lighting in houses, and the working of some of the powerful dynamo machines used in connection with large installations, has been encouraged by the occurrence of a few cases of fire in buildings where the fittings have not been properly executed, and of a few fatal accidents resulting from the employment of inexperienced or heedless men in working machines which engender currents of extremely high electromotive force. Accidents from the first cause can be effectually guarded against by careful attention; and the probabilities of fire being originated by electric light fittings in houses are certainly small as compared with actual casualties attending the use of gas, petroleum lamps, and other illuminants. With respect to the second class of accidents, it had been pointed out that if the electromotive force circulated in conducting wires does not exceed 600 volts neither danger to life nor injury to health can result from the careless handling of conductors or parts of a machine, and that, so long as the size of conductors is in ample proportion to the work to be done, no necessity arises for exceeding the safe limits of what may be termed electrical pressure. As regards the future of electric lighting, especially incandescent lighting, Sir Frederick spoke hopefully, quoting authorities to show that considerable improvement might be expected in the construction of glow lamps, possibly even improvements which would reduce the cost of the light to one-fifth the present amount. The other practical applications of electricity and the progress made in them were next passed in review; the advances in the development of electrical railways in Austria, Germany, and the United States, as well as in these islands, and the possibility of using electrical power more extensively than has yet been done for propulsion on water were described; and this part of Sir Frederick's address concluded with an approving notice of the system of electric transmission of power to which its inventor, Professor Fleeming Jenkin, has given the name of "Telpherage." Sir Frederick Abel also spoke approvingly of the efforts made by Captains Renard and Krebs, the two French officers attached to the Military Balloon Establishment at Meudon, whose recent trips have attracted so much public attention; still, but little real progress has been made.

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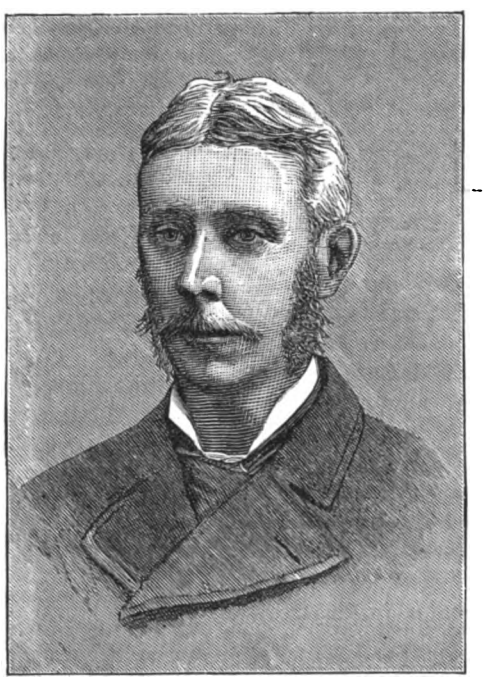
ROOKES EVELYN BELL CROMPTON.

CROMPTON, ROOKES EVELYN BELL: Born near Thirsk in Yorkshire 1845, educated at Elstree Hill School, Harrow School, and in Paris; entered the army, and appointed to the Rifle Brigade in 1863. Served with his regiment in India until 1869; from 1869 to 1875, held an appointment under the Department of Public Works as engineer in charge of the Government steam train. During this time he carried out for the Indian Government a long series of experiments on traction by steam on the roads of India. In 1876, left the service and became a partner in the firm of T. H. P. Dennis and Co., of Chelmsford. A year later he became engineer in chief of the Stanton Iron Works Company. For this company he designed and superintended the construction of their foundry, which is one of the largest in the United Kingdom. Shortly after the completion of the foundry, necessity for working continuously day and night led him to study the possibility of adopting the electric light, which at that date, 1877, was a novelty in this country. Early in 1878 he purchased for the company a plant of two Gramme machines and two Serrin lamps. The following year he commenced the manufacture of electric light apparatus in a small building attached to Messrs. Dennis's works at Chelmsford. His first inventions related to burning arc lamps in partial vacua, and to the improvements in the arc lamps themselves. These improvements were exhibited at the Agricultural Show in Kilburn in 1878 and at the exhibition of electric light apparatus held at the Albert Hall in 1879. The lamps were made for practical use, and a considerable sale was soon obtained for them. In 1879, through the instrumentality of Mr. Brown, the well known tramway engineer of Winterthur in Switzerland, Mr. Crompton made the acquaintance of Mr. Bürgin, of Basle, who had just brought out his dynamo electric machine. Mr. Crompton at once laid out works on a considerable scale at Chelmsford for the construction of this machine. In conjunction with Mr. Bürgin he introduced considerable improvements, and converted the original machine, which was only capable of driving one arc lamp, into one giving a current of higher E.M.F., and capable of driving four or five lights in series. The lighting at Queen-street Station, Glasgow, King's Cross Station, London, the Bricklayers' Arms, London, and the Mansion House, are instances of works successfully undertaken about this period. In 1879 Mr. Swan invited Mr. Crompton to Newcastle to see the incandescent lamp tried on a commercial scale, and the question of manufacturing dynamo machines suitable for working the incandescent system was seen to be of the greatest importance. In 1881 Mr. Crompton exhibited largely at the Exposition International d'Electricité at Paris, and obtained one of the few gold medals awarded to English firms; and in the following year he again exhibited at the Crystal Palace and obtained another gold medal. Shortly after this he commenced the investigation of the subject of making self-regulating dynamo machines, and with the assistance of Mr. Kapp, who had become his works manager, he brought out the now well-known system of winding the field magnets of dynamos with series in addition to shunt coils. To machines thus wound he gave the name of "compound" machines, and this name has been generally adopted by makers and users of such dynamos. The invention of compound winding has been claimed for others, but it remains a fact that the first dynamo machines made practically self-regulating by the compound principle were those made and set to work by Messrs. Crompton for Mr. Coope at Berechurch Hall, near Colchester, in the spring of 1882.



Believing that the best method of supplying the electric light to the public in their private houses would be in the nature of a co-operative supply, similar to that of gas and water, Mr. Crompton took an active part in the enlargement of the original Swan Company into the Swan United Company, hoping thereby to form a powerful corporation for the supply of electric lighting to large districts in London. He also devoted a great deal of time and attention to the Electric Lighting Act, and subseqnently to obtaining from the Board of Trade provisional orders for the Swan United Company, and for other companies, for lighting various parts of London, Birmingham, &c. He prepared most of the technical information for Mr. Moulton, enabling that gentleman to draft the provisional orders which were afterwards adopted by the Board of Trade with but slight modification as their model provisional order. He protested in the strongest terms against the introduction of the 21 years' purchase clause, which has been considered so fatal to the electric light companies. Mr. Crompton has never sold any of his patents, although at the time of the electric light mania he had many tempting offers to do so. Seeing that over speculation was likely to retard for many years the accomplishment of the house-to-house electric lighting on a large scale, he again turned his attention to the laying down of isolated installations and to the general improvement of electric light machinery, and with the result that during the last three years he has, either alone or in conjunction with other co-workers, brought out a long series of inventions in arc lighting, electric conductors, street mains, accumulators, dynamo electric machinery, and electric governor apparatus for steam engines and other prime movers. During the last two years he has been engaged in perfecting a new type of dynamo machine, which has given remarkable results, far exceeding those he was able to obtain from the Bürgin or any of the contemporary machines. The development of his works at Chelmsford has gone on hand in hand with the development of electric lighting, although, as we have seen above, these works were only commenced in 1878. In this year, 1884, they cover several acres of ground, and employ over 300 men.

We believe that Mr. Crompton, in conjunction with Mr. Norman Lockyer, F.R.S., investigated spectroscopically and otherwise the varying conditions of the electric arc from the point of contact to the complete breaking of the circuit; but no detailed results of this investigation have as yet been published. He was also greatly interested in the experiments which proved the lighting of mines by electricity practicable.

It is sometimes unfortunate that the greater portion of periodical technical literature is anonymous, so that but few people know the authors to whom they are indebted for valuable information. Mr. Crompton has greatly enriched technical literature either by writing or otherwise communicating information, and has contributed several papers to the *Transactions* of learned societies, principally the Society of Telegraph Engineers, of which society he is a member of the council. So far as we know, only a small work on electric lighting has been published independently, although some of the papers have been republished by Messrs. Spon, of Charing Cross.

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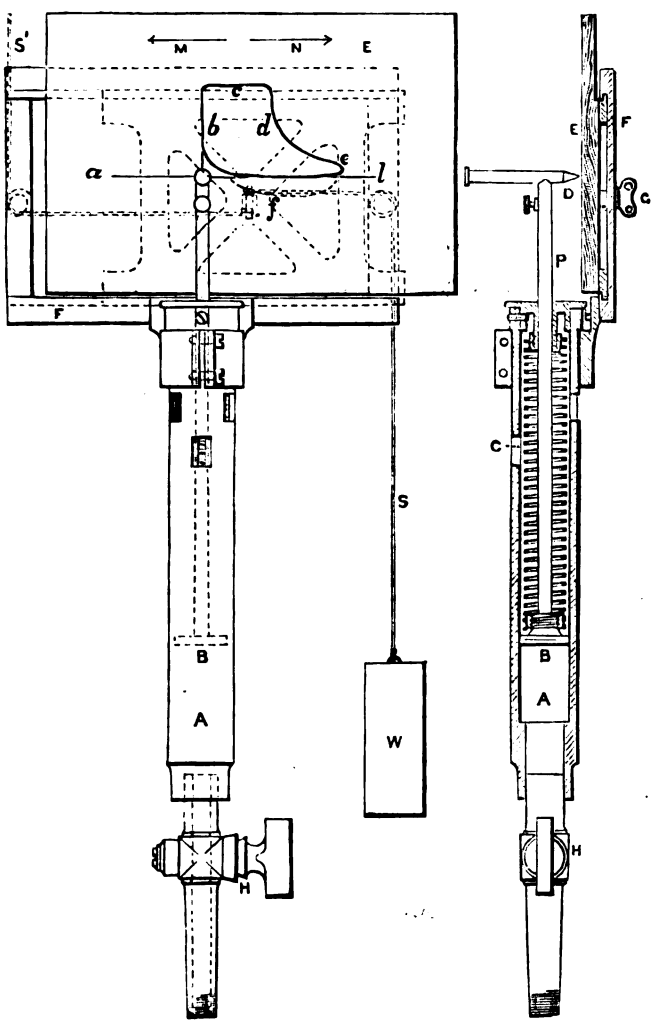
THE STEAM ENGINE INDICATOR.—II.

BY AMICE.

Watt's indicator should be here described, as it may be taken as illustrating the simplest form of the instrument, and our younger readers will be assisted by reference to its construction. Several of these indicators are still in existence, and the accompanying engravings from the *Proceedings* of the Institute of Mechanical Engineers, 1883, is made from one of these.

Although, generally speaking, and as concerns practical work, the indicator as made by Watt is of little more than historic interest, it is of considerable educational value, because a knowledge of this, as the simplest form of indicator, will make the principle of the instrument more easy of acquirement than if described by reference to its modern representative, while an explanation of its defects will make clear the reasons for the steps in the development of those now most used. It will therefore be described here at length, not because of its historic interest, but as being necessary to our purpose.

FIG. 4. FIG. 5.



Watt's Indicator.

From our engravings, Figs. 4 and 5, it will be seen that a cylinder, A, is fitted with a piston, B. To this is attached a piston rod, P, which at its upper end carries a pencil, D. The piston B moves upward in the cylinder, under the action of steam admitted by the cock H. Above the piston is a spring, C, the strength of which is known; that is to say, the number of pounds which is necessary to compress it through a given range is ascertained before it is used in the indicator. Suppose, for instance, it takes a weight of 10lb. to compress the spring one inch; then when it is placed in the indicator it will require 10lb. to do the same compression, and if the cylinder be one inch in diameter, and consequently 0·7854″ sectional area, it will require a steam pressure of $\frac{10}{0{\cdot}7854}$, or 12·719lb. per square inch to compress the spring and raise the piston one inch. In practice, however, the springs are made of such strength that they will compress through a range of one inch with a pressure represented by a convenient number, and in the above case the spring would be of such strength that with a steam pressure of 10lb. per square inch it would compress one inch, and therefore with a load of $10 \times 0{\cdot}7854 = 7{\cdot}854$lb.

Mounted with slides in the frame F, as seen in Fig. 5, is a board, E, to which is attached the piece G. Fastened to G is one piece of string, S, running over a small pulley, and carrying the weight W, and another piece of string, S′, running over another pulley and attached to some part of the engine which has a reciprocating movement synchronous with that of the piston of the engine. The board E is thus pulled in the direction M by the string attached to some part of the engine, and as that part returns with the return stroke of the engine piston, the weight W pulls the board back in the direction N. The weight W thus acts in pulling the board E in one direction, and also prevents any slack in its movement. The cock H being screwed into one end of the steam engine cylinder, the cylinder A of the indicator receives steam at the same time as the engine cylinder, and at the same time the board E is put into motion by the engine. A piece of paper is attached to the board E, and the board allowed to be moved by the engine before steam is admitted to the indicator cylinder A. The pencil being lightly pressed against the board, the line *a l* will be made, and will represent the pressure of the atmosphere. It will now be seen that the engine piston being at the end of its stroke, and steam being admitted to the cylinder, it will also be admitted to A, and the pencil D will instantly rise and trace the line *b*, which will have a height according to the steam pressure. The engine piston being now in motion, the board E is pulled in the direction M, and the horizontal line *c* is traced. This line will be at a height above the line *a l*, which will represent the maximum pressure per square inch in the steam engine cylinder, and if the ports in that cylinder are of sufficient size and the movement of the slide valve sufficiently rapid, this pressure will be maintained in the cylinder until near the point at which the entrance of steam into the cylinder is cut off by the slide valve. From that point the pressure of the steam falls in the cylinder, as shown by the curved line *d*, this line being the expansion curve, or the line which shows the pressure existing in the cylinder at any part of the stroke of the piston during the expansion of the volume of steam admitted up to the point of cut off. At *e* the exhaust port is opened, and steam instantly rushes into the atmosphere, or into the condenser, if the engine is fitted with the latter, and the pressure falls correspondingly, and the pencil with it. At the same time the return stroke of the engine commences, and the weight W pulls the board E back as that stroke is made, and the pencil D traces the line, completing the diagram, this line being nearly parallel with and nearly coincident with the atmospheric line *a l*, if the engine is non-condensing. If the engine is fitted with a condenser the pressure falls below the atmospheric pressure; in other words, a vacuum more or less complete is made by the condensation of the steam, and the line *f* is traced. In this case the pressure against the engine piston is represented by the distance between the line *f* and *c d*, instead of between the line *a l* and *c d*. To the form in detail of the diagram we shall recur hereafter.

The steam engines made by Watt were all very slow speed engines, and a low pressure of steam was used. Under these conditions a spring of rather long range and with the pencil attached direct could be used. The return motion of the indicator paper or card could also be effected by a weight, as shown. With the use of high pressures and high speeds, however, it became necessary to alter these parts. In the first place, board E of the Watt indicator was large and inconvenient, and the weighted string acted in a jerky manner, making the movement of the board unsteady, especially in the direction N. To overcome these objections, the indicator known as M'Naught's was made. In this the range

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of movement of the pencil was, like Watt's, the same as that of the compression of the spring, but the board E was replaced by a vertical hollow cylinder turning upon a vertical axis. This cylinder contains a spring, which takes the place of the weight W in Watt's indicator, and the paper or card being placed upon it, the pencil traces the diagram exactly as on the flat board. This improvement did not remove the defect due to the use of a long range spring and of a pencil attached thereto, the effect of which was that with high pressure steam and quick running engines the instantaneous compression of the spring was followed by a series of elastic oscillations, sometimes of considerable range, aggravated by the inertia of motion of the piston and attached parts, and causing the pencil to trace an irregular line, which reduced the value of the diagram as an indication of the behaviour of the steam in the cylinder. The pencil would trace a line as

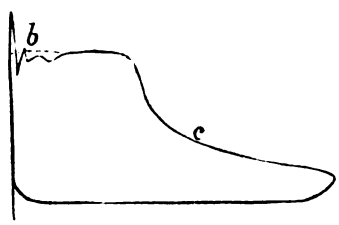

FIG. 6.

shown at *b* (Fig. 6), making it difficult to obtain the mean pressure line, which would probably be as indicated by the dotted line. In very high speed engines the whole of the line from *b* to *c* (Fig. 6) was of an irregular character, giving evidence of tremulous movements due to the indicator itself, and not at all due to the engine. To remedy these defects Mr. C. B. Richards, an engineer living at Hartford, Connecticut, designed the indicator known by his name. McNaught's indicator is only to a small extent employed now, other forms are much more used, the Richards indicator being still the best known.

With a description of this we shall commence our next article.

THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 8.)

Three Similar Coils and Cores.

With the same notation, the equation of E.M.F. in the circuit is, by an obvious extension of (102),

$$0 = H_1 + \frac{L-3M}{R}\dot{H} + s(H'_1 + H'_2 + H'_3) \quad . \quad . \quad (110)$$

and, if

$$AJ_0(nr_1)e^{Dt}, \quad BJ_0(nr_2)e^{Dt}, \quad CJ_0(nr_3)e^{Dt}$$

be a normal system, continuity of current in the circuit requires that

$$AJ_0(nc) = BJ_0(nc) = CJ_0(nc);$$

giving $A = B = C$, when $J_0(nc)$ does not vanish. Corresponding to (105) we have the determinantal equation

$$\{J_0(nc)\}^2 \left\{ (1 + \frac{L-3M}{R}D)J_0(nc) - 3snJ_1(nc) \right\} . \quad . \quad (111)$$

with two sets of roots, as in the last case, the first set corresponding to circuit broken, the second set to a single coil with circuit closed.

Regarding the ratios A:B:C when the roots are those of the first set, we may be guided by physical considerations. Decompose the initial magnetic forces H_1, H_2, H_3 into

$$\begin{aligned} H_1 &= \tfrac{1}{3}(H_1 + H_2 + H_3) + \tfrac{1}{3}(H_1 - H_2) + \tfrac{1}{3}(H_1 - H_3), \\ H_2 &= \quad \text{ditto} \quad + \tfrac{1}{3}(H_2 - H_1) + \tfrac{1}{3}(H_2 - H_3), \\ H_3 &= \quad \text{ditto} \quad + \tfrac{1}{3}(H_3 - H_1) + \tfrac{1}{3}(H_3 - H_2). \end{aligned}$$

The portion $\frac{1}{3}\Sigma H$ common to all three obviously requires the use of the second set of roots. The other six terms cancel one another as regards E.M.F. in the coil circuit. Thus, $\frac{1}{3}(H_1 - H_2)$ in first core and $\frac{1}{3}(H_2 - H_1)$ in the second cancel, and similarly for the other two pairs. They therefore require us to use the first set of roots only. We may write the decomposition thus,

$$\left.\begin{aligned} H_1 &= \tfrac{1}{3}\Sigma H + (H_1 - \tfrac{1}{3}\Sigma H) \\ H_2 &= \tfrac{1}{3}\Sigma H + (H_2 - \tfrac{1}{3}\Sigma H) \\ H_3 &= \tfrac{1}{3}\Sigma H + (H_3 - \tfrac{1}{3}\Sigma H) \end{aligned}\right\} \quad . \quad . \quad . \quad (112)$$

Consequently the solution for the three cores is to be found in a similar manner to before. Starting with any arbitrary distributions, substitute for them, first a distribution $\frac{1}{3}\Sigma H$ in every core, and let them subside according to the second set of roots, adding their effects in the coil circuit. And let simultaneously the complementary distributions $H_1 - \frac{1}{3}\Sigma H$, &c., subside, each in its own core independently, according to the first system. The resultants will give the actual state of things. The curves of axial subsidence, when the initial distributions are constant, may be found from curve h_0h_0 (Fig. 3), and either H_0H_0 or a similar one, by constructing three new curves whose ordinates are made up of those of H_0H_0 and h_0h_0 taken in the proper proportions expressed in (112).

Any Number of Coils.

The extension to any number m of equal coils, with equal cores, in sequence, is plain. The determinantal equation is

$$\left\{ J_0(nc) \right\}^{m-1} \left\{ \left(1 + \frac{L-mM}{R}D\right)J_0(nc) - msnJ_1(nc) \right\} = 0 \quad (113),$$

with the two sets of roots as before, the repetition of the roots of $J_0(nc) = 0$ only affecting the ratios of the constants A, B, C, &c., in a normal system. The decomposition is

$$\left.\begin{aligned} H_1 &= \frac{1}{m}\Sigma H + (H_1 - \frac{1}{m}\Sigma H) \\ &\cdots\cdots\cdots \\ H_m &= \frac{1}{m}\Sigma H + (H_m - \frac{1}{m}\Sigma H) \end{aligned}\right\} \quad . \quad . \quad (114).$$

The mean distribution $\frac{1}{m}\Sigma H$ is what makes the coil current. This distribution must be imagined to exist in all the cores, each with its proper complementary distribution; the mean distribution to subside one way, using the second set of roots, the complementary to subside as if the coil circuit were interrupted. It is unnecessary to write out the developments, such being merely repetitions of the solutions in Examples 1 and 2 or 3. But the general case of any number of dissimilar coils and cores joined in sequence, of which the above is a special case, does not admit of the reduction to two simple solutions, so its theory will form the subject of a later section.

Equal Coils, with Cores, in Parallel.

Two coils in parallel being the same as two in sequence, nothing more need be said about it. We may consider the theory of three coils in parallel, and its natural extension to any number. Let P and Q be the common terminals of the three branch conductors containing the coils; every branch to have the same resistance and self induction, and to contain a coil with a core, the three coils being alike, and also the three cores. Let Γ_1, Γ_2, Γ_3 be the three currents, reckoned from P to Q, and V the fall of potential from P to Q. This being the same for the three branches, we have the equation of E.M.F.

$$V = R\Gamma_1 + (L-M)\dot{\Gamma}_1 + S\Gamma'_1 \quad . \quad . \quad . \quad (115)$$

in the first branch, and two similar equations with Γ_2 and Γ_3 written for Γ_1. Here $S = M\rho/2\pi\mu c$, and L and M are the coefficient of self induction of a branch, and that part of it due to the core. We have also the equation of continuity

$$\Gamma_1 + \Gamma_2 + \Gamma_3 = 0; \quad . \quad . \quad . \quad . \quad . \quad (116),$$

the sum of the currents meeting at P or at Q being zero.

A normal system of magnetic force in the cores being

$$A_1J_0(nr_1)e^{Dt}, \qquad A_2J_0(nr_2)e^{Dt}, \qquad A_3J_0(nr_3)e^{Dt},$$

with the currents in the coils

$$A_1J_0(nc)e^{Dt}/4\pi N, \qquad A_2J_0(nc)e^{Dt}/4\pi N, \quad A_3J_0(nc)e^{Dt}/4\pi N$$

to correspond, substitution of the latter for Γ_1, Γ_2, Γ_3 in (115)

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and (116) gives, by eliminating V and the A's, the determinantal equation

$$J_0(nc)[\{R+(L-M)D\}J_0(nc)-snJ_1(nc)]^2=0, \quad . \quad (117);$$

or say $xy^2=0$; giving the two sets of roots belonging to $x=0$, and $y=0$. The equation $x=0$ means that there is no current in any of the coils, and $y=0$ that the terminals P and Q are at the same potential, as if the three branches were put on short circuit.

There being two manners of subsidence of initially given distributions of magnetic force, which we shall refer to here and later as the first manner (no coil current or circuit broken), and the second manner (branch containing a coil on short circuit), it only remains to properly effect the division of the given distributions into two distributions, such that one will give no current in the coils, and the other will give currents subject to the condition of continuity (116). Now, if we start with a distribution H_1 in the first core, and none in the others, and substitute the distributions $\frac{1}{3}H_1$, $\frac{1}{3}H_1$, $\frac{1}{3}H_1$ in the first, second, and third cores, these will subside in the first manner, owing to the balanced E.M.F.'s; whilst the distributions $\frac{2}{3}H_1$, $-\frac{1}{3}H_1$, $-\frac{1}{3}H_1$, which with the former make up the given real distributions H_1, 0, 0, will give currents complying with (116); *i.e.*, a current in the first branch from P to Q dividing equally between the second and third branches, in which it is directed from Q to P. This is the proper division so far as H_1 is concerned, and those for H_2 and H_3 may be similarly constructed. Putting all together, we find the proper division when H_1, H_2, H_3 are all finite, is

$$\left.\begin{aligned} H_1&=\tfrac{1}{3}\Sigma H+(H_1-\tfrac{1}{3}\Sigma H),\\ H_2&=\tfrac{1}{3}\Sigma H+(H_2-\tfrac{1}{3}\Sigma H),\\ H_3&=\tfrac{1}{3}\Sigma H+(H_3-\tfrac{1}{3}\Sigma H),\end{aligned}\right\} \quad . \quad . \quad . \quad (118)$$

the common mean distribution $\frac{1}{3}\Sigma H$ in each core to subside in the first manner, and the remainders in the second manner, furnishing the coil currents.

Contrast with the case of three coils in sequence, the division being represented in equations (112). These are the same as (118), but whereas in the latter case the mean distribution furnishes no coil current, in the former it is the mean distribution that supplies the coil current.

The extension to any number m of equal coils in sequence may be shortly stated. The determinantal equation is

$$xy^{m-1}=0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (119)$$

which may be compared with (113), the corresponding equation when the coils are in sequence, which, written similarly to (119), is $yx^{m-1}=0$.

The proper division of the initially given distributions of magnetic force in the cores is given by equations (114), only noting that the mean distribution $\frac{1}{m}\Sigma H$ must now subside in the first manner, instead of, as in the case to which (114) relates, in the second manner, with the corresponding change as regards the complementary distributions.

(TO BE CONTINUED.)

LITERATURE.

Arithmetical Physics. Part IA. Acoustics, Light and Heat. Part IIA. Magnetism and Electricity. By C. J. WOODWARD, B.Sc. [London: Simpkin, Marshall, and Co.]

There is nothing like being a teacher in order to explain what you really know of a subject, and how to put that subject to a learner. We do not refer to teachers who are merely teachers for so many pounds a year, and who are as little related to real teachers as a cat is to a fire-shovel. Teachers of the physical sciences necessarily require a large number of exercises or questions to be put to the pupils, either for clinching the moral of a tale or examinational purposes. It is an immense labour to have to make these questions for oneself, yet we should not advocate the entire dependence upon any collection. Mix them. Then, again, special courses are held preparatory to various examinations in which special points arise requiring special questions. In these books Mr. Woodward has had in view the preparation for the London Matriculation and the First Stage of the Science Department. The books are admirable of their kind. They provide a *memoria technica* of the principal laws and rules for the solving of problems, interspersed with questions fully solved, followed by a large collection of examination questions, the whole forming a valuable adjunct to the science teachers' apparatus.

Exercises in Electrical and Magnetic Measurement. By R. E. DAY, M.A. New Edition. [Longmans, Green, and Co.].

It is almost two years ago—*vide The Electrician*, Vol. X., p. 70—that we had occasion to notice the issue of a little work, by Mr. Day, entitled "Electric Light Arithmetic." We have used that work a good deal, and found it very useful. It had its defects, however, in that it was too small, and contained a number of misprints. The old book contained some eighty pages, the new edition contains more than one hundred and eighty, and in addition the page is larger. These facts show that the subject matter has been largely extended. The plan adopted is to deal with the subject in sections, there being no less than twenty sections. It will be sufficient to analyse one of these. Take, then, the first, on "Electrostatics." The section commences by giving a question bringing out the fundamental formula $F=\frac{q_1\times q_2}{d^2}$, where F = force, q_1 q_2 = quantities, d = distance. When unit quantities and unit distances are taken, the result F is in dynes, or unit force. The formula is followed by specimen solutions and questions for the student to solve. Density and charge are similarly treated. Thus we have formulæ followed by solved and unsolved questions upon the formulæ. Differing from the ordinary books of questions, which are generally compiled for examination purposes, these formulæ and questions are such as come daily before the worker in his practice. Here the practical man will find practical questions on "heating effects," "shunts," derived circuits generally, resistance, conductivity, "magnetic action," and so on, enabling him not only to go to work by the rule of thumb method, but in a short time to work with the exactitude which, in electrical work, contributes so much to success. We think a study of the book and the solutions of the questions will prove beneficial to every student.

PORTABLE STORAGE BATTERY FOR MINES.—At the last meeting of the Engineers' Club of Philadelphia, Mr. C. Henry Roney showed a portable storage battery for mining and exploring purposes, with small incandescent lamps, illustrating his remarks with blackboard sketches. The battery shown was a modification of Planté's, devised by Dr. E. T. Starr, of Philadelphia, the electrodes consisting of V-shaped plates of sheet lead arranged over each other, the convexity downward, with a slight interval between them, their ends attached to a lead frame by "burned" joints, the interstices between the plates being filled with finely divided metallic lead, exposing a large surface to oxidation and reduction when subjected to dynamic electric or voltaic energy, and, in turn, giving off a large percentage of the stored energy to incandescent lamps placed in the circuit. The battery shown measured 3¼in. long, 2¾in. high, and ¾in. thick, and would maintain a small two-candle incandescent lamp at incandescence for about one hour. A battery sufficiently large to run an eight-candle lamp for ten or twelve hours would not be too large or heavy to carry conveniently for mine or other underground exploration.

ELECTROLYTIC REDUCTION OF GOLD.—Henry R. Cassel, of New York, has invented a process by which 95 per cent. of the gold contained in the most refractory quartz may be extracted at the cost of a few shillings. The process is said to require only the decomposition of water, common salt, and lime by electrolysis, the gold being separated exactly in the manner adopted by nature to impregnate the water of the ocean, every ton of which is supposed to contain a certain number of grains of gold. We learn that a powerful syndicate has acquired the patent rights.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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THE ELECTRIC LIGHTING ACT.

The President of the Board of Trade received a deputation on Thursday last representing the chief electric lighting companies, on the subject of the Act with which his name is so closely identified. The deputation was introduced by Lord Thurlow, the Chairman of the Brush Company, and included such well known representatives of the electric lighting industry as Sir Frederick Bramwell, Sir Daniel Cooper, Mr. R. E. B. Crompton, Mr. J. S. Forbes, Mr. R. Hammond, and Major Flood Page. It is now confessed in every quarter that the Electric Lighting Act is not to be numbered among the triumphs of legislation. The Chairman and Directors of the United Swan and Edison Company have therefore acted wisely in pressing an interview on their over zealous patron at the Board of Trade; and he in turn has acted with his usual discretion in according it. As was expected, he threw most of the blame on the interviewers; but one thing is beyond him, he cannot deny the utter failure of the Act for which he is responsible, nor the necessity for amending it if Electric Lighting is to enjoy the future that was predicted for it.

It was naturally argued that the undertakers of Electric Lighting were themselves responsible for some of the provisions of the Act, if not indeed for its initiation. This may be frankly admitted; for in the first place it was thought that compulsory powers of some kind would be required for carrying out the installations, and no doubt they are. The powers they got, however, were not at all what they bargained for, and what they had to give in exchange even for these was a great deal more than they would have voluntarily agreed to. But they had no choice. Having hooked his fish, Mr. Chamberlain would release it only on his own terms; and for these terms he alone is responsible. In the second place those provisions of the Act traceable to the companies, if we are not misinformed, stand good now, and are not challenged. Lastly, the Act as a whole, when it received its final touches, was protested against at the time, and was only allowed to pass because nothing better could be had. It was doomed to failure from the first, and if it had been framed solely in the interests of the existing gas companies, or the Corporation of Birmingham, it could hardly have been more hostile to the prospects of Electric Lighting interests.

We believe, however, that the Act was framed in no such spirit as that. What we do believe is that it had the misfortune, like many another parliamentary measure, to be cast in a political mould; and that the mould in this instance was a peculiarly narrow and tortuous one. Mr. Forbes was near the mark the other day when he told the shareholders of the Swan and Edison Company that the Board of Trade were so afraid of Electric Lighting becoming a frightful monopoly that they tied it up in every direction, and had succeeded in making it an impossibility. The letter which this Company has addressed to the President of the Board avoids all reflections of this kind. But no such reticence is imposed upon us. The only way to discredit the Act as it deserves is to expose the spirit in which it was framed; and we are confident that this spirit was prompted by a political fad, and nothing better. It was a spirit hostile to what are called vested interests. Vested interests! Why should not interests be vested? The term implies collective proprietorship; and the bare description of it in this simple form reveals how fanatical and captious must be the objectors who think to discredit it by applying to it an epithet which is perfectly harmless, but which has come to be one of the red rags of political strife. As a matter of fact, no interests can long exist unless they are vested, and no vestiture of them is possible except with the certainty of peaceful possession. This is a lesson which the assailant of existing interests may be slow to learn; but the lesson that new interests cannot arise in an atmosphere filled with the cry of confiscation has already been taught by the experiment with the electric lighting companies; and we take it that Mr. Chamberlain's willingness to receive a deputation from them is evidence that he is making progress in learning. His language on this point last Thursday confirms our impressions.

The letter which has been addressed to him is clear and unanswerable on the point just adverted to, and was ably handled by the deputation. Under the provisions of the Act the local authorities have compulsory powers of purchasing the business of the undertakers at a market valuation, whilst the undertakers have no powers to compel purchase on any terms whatever. Thus, if the business has succeeded, or by the time the working period has run out is about to succeed, the local authorities will buy; but if it has been unprofitable they will let it alone. Nothing but a political craze, we venture to say, could have blinded any otherwise sensible person to the impossibility of creating a new industry under such conditions as these, to say nothing of their iniquity. Nobody would start a chandler's shop on that

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basis; and we know of no business so certain of success within a given number of years as to freely promise to sacrifice itself when the term has expired. Business men are perhaps as philanthropical as their customers, but not more so; and we have no more right to expect a number of men called shareholders to risk their money in the interest of the public than we have to ask the public to risk theirs in the interest of the shareholders. Heads I win, tails you lose, though smart enough to provoke a laugh, is not a motto for honest tradesfolk; and it certainly ought not to be the leading principle of an Act of Parliament framed by a British Minister of Trade. There are several other objectionable, impracticable, and even preposterous provisions which would alone render the Bill unworkable; but so long as the confiscatory clauses remain in it without very considerable modification, so long will no attempt be made to make any part of it workable.

CORRESPONDENCE.

THE WATT AND HORSE-POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to Mr. Preece's paper on "The Watt and Horse-power," which was read before the British Association at Montreal, and which is given in your issue of October 4th.

After a lapse of seven months from the time of the delivery of my addess to the Society of Telegraph Engineers and Electricians, Mr. Preece states at Montreal that I had spoken "of the watt as the unit of work, and had given its value in kilogrammetres;" and gives this as an instance of the "strange mistakes which are made in confusing the unit of power with the unit of work."

Now, on looking through my Address to find what I can have said to lead Mr. Preece to say that I had spoken of the watt as the unit of work, I looked in vain through the text; for I have not given a definition of the watt or spoken of it in any way except where it is used in its true sense, and where it *could not be understood*, by any intelligent person reading the context, as being used in any other than its true sense.

On page 24 I state "the number of watts $= c^2(a+f+r) =$ 5031·5 and the electrical horse-power $= \frac{c^2(a+f+r)}{746} = 6{\cdot}7461$, showing that watts and horse-power are things of the same name." But in a tabular statement on the same page, where there was not room to enter more than is absolutely necessary, I have put

Units of work, or watts, 5,012 ..... watts, 5,053.

Now, here there is no confusion as to watts, but any one very captious might say that I did not know what a *unit of work* was. It is quite impossible that these units of work could mean anything else than watts, and I hold that units of work per second are still units of work as much as revolutions per minute are still revolutions. In fact, Mr. Preece makes the same or even a greater mistake when, in his paper on "The Use of Secondary Batteries," he speaks of "the *total* electric energy being 815 watts."

But Mr. Preece's charge does not end here. In a supplementary note to my paper, consisting very much of tables of results, I have given the number of watts, and for the sake of convenience have indicated at the bottom of the table the multiplier employed to convert these into kilogrammetres per second; but as there was not room in the table, and as the term "kilogrammetres" could there have no other meaning than kilogrammetres per unit of time, it was unnecessary to state it more fully. On the succeeding page opposite to watts I have put (E C), to indicate clearly the meaning of watts.

In the large table at the end, where there was room, I have placed the heading, "Energy Absorbed per second in Watts," but I am afraid Mr. Preece will charge me with not knowing what is meant by a revolution, because in that table, in speaking of the revolutions of dynamos, I have not thought it necessary to put the heading, "Revolutions of Shaft *per Minute*." But what is the explanation which Mr. Preece gives of the matter. He states, as given in *The Electrician*, that "work done at the rate of a kilogrammetre per second = 981 watts $= g$ watts." Besides the omission of a point which alters the statement materially, I think that here we have some confusion, for surely g means a concrete quantity, *the acceleration due to the force of gravity*, whether measured in feet or in centimetres, per second, and therefore we must understand by Mr. Preece's statement "work done at the rate of a kilogrammetre per second" = 981 centimetres per second watts. Again, in the paragraph following the table we have the statement, "a standard sperm candle develops 4,000 foot-pounds per minute. Now, since a watt is equivalent to 44·2 foot-pounds per minute, it follows that a standard candle develops 90 watts per minute." So that, in other words, according to Mr. Preece, a standard candle develops 90 units of work per second per minute. The same mistake is repeated no less than four times in the same paragraph. I am afraid that if my address was confused we have here confusion worse confounded.—Yours, &c., W. GRYLLS ADAMS.

AN INDEX.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have recently received an expensive work on "Electric Lighting," from which I expected great things, but have been entirely disappointed.

Not one of the numerous works on that and kindred subjects which I have yet seen is to be compared with the contents of your excellent journal for details of description and range of practical information. When I look at the twelve noble volumes of *The Electrician*, it seems absurd to expect that any one book, published up to the same date, can add much, if anything, to what they contain, whilst the comparison is greatly in favour of your periodical.

There is but one drawback, which is the trouble and time required in searching out the buried treasures. There is a crying need for a really good index to the first twelve or thirteen volumes. An index in which everything referring to any *subject* is entered under *that as a heading*, whilst sub-headings may indicate whether the article comes under "Notes," "Correspondence," "Leading Articles," "Companies' Meetings," &c. We should have to look at one spot only to find all the references to any subject; whereas in the present half-yearly index it is necessary to look up any one subject under each of these several headings.

I would sooner by far pay ten or fifteen shillings for such an index as described than for all the books on "Electric Lighting," &c., which I have ever yet seen. Its publication would be a boon to large numbers besides myself. May we hope for it?—Yours, &c., J. C. CUFF.

The Eastern Extension, Australasian, and China Telegraph Company, Singapore, October 15, 1884.

HENRY FAWCETT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your journal is so intimately associated with the latest and most interesting development of the public department of the Post Office that I dare say you will kindly find space for a few words of mine which the death of the Postmaster-General seems to suggest. I have had to do with several of the figure heads of the Post Office, and undoubtedly Mr. Fawcett was the best type. He, however, was too deferential to his predecessor to be sufficiently impartial in carrying out every effort he evidently desired in order to advance the telegraph service of the State. I have myself waited many years for the Post Office to keep faith with me in so simple a matter as naming a time for the meeting of the referees which have been appointed on both sides. Mr. Fawcett had this urged upon his attention by me four times in the months of July and August, 1880, before any answer was given, and then he stated merely that "he

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did not feel called upon to enter into the past history of the case." I wrote to him again, pointing out the injustice of leaving a matter of such serious importance to me unfinished, and only because a new Ministry had appointed a new chief, but although I again asked twice for his attention to the matter, he made no reply.

In its eulogy of Henry Fawcett the current number of the *Spectator* has the following outburst—

"O light unto thy country, who hast lent
Eyes to the dim hope of the ignorant!
Why the great form of Justice standeth blind
Thou dost make plain."

My experience, however, has not carried me as far as this. In fact, after seven years I would still repeat and shall urge upon successive Postmasters-General what I suggested in my pamphlet on "Sound Constitutional Principles in Theory and Practice," then published by Longmans, that "it would be highly instructive if a return was made to Parliament of the number of petitions presented to the Crown, say during the present reign, and of the number of those in which redress was obtained, or even in which the complaints of the petitioners received any serious attention. The scope of this field of usefulness is great, and fully worth the attention of a vigorous and independent successor even to Henry Fawcett.—Yours, &c.,

RICHARD HERRING.

27, St. Mary's-road, Canonbury.

ALTERNATE CURRENT MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in the current number of *The Electrician* a report of Dr. Hopkinson's paper recently read before the Society of Telegraph Engineers on the electro-mechanical property of the alternating current to synchronise the rotations of the armatures of a number of magneto-electric machines when their circuits are connected. May I be permitted to state that this remarkable property of the current was discovered by me in 1868, and is fully described in the *Phil. Mag.* for January, 1869.

As my paper was much in advance of the electrical knowledge of the time, and may not have had many readers, I shall be glad if you will find a place for the following copy of it in your valuable journal.—Yours, &c.,

H. WILDE.

Rockside, Alderley Edge, Cheshire,
Nov. 17, 1884.

ON A PROPERTY OF THE MAGNETO-ELECTRIC CURRENT

To Control and Render Synchronous the Rotations of the Armatures of a Number of Electro-Magnetic Induction Machines.*

The discovery of the property which I am about to describe arose out of the efforts which have been made, during the last two years, to reduce the internal heat generated in an electro-magnetic machine by the induction currents set up in the electro-magnet and armature by the rapid magnetisation and demagnetisation of the latter. This heating of the armature (as is well known) was first observed by Dr. Joule in 1843, as the result of a delicate investigation on the quantitative relation existing between ordinary mechanical power and heat.† In the electro-magnetic machines of my invention this phenomenon unfortunately manifests itself on an alarming scale, so much so that the armature of the 10in. machine rises in the course of a few hours to 300° F. and upwards; and were the action of the machine to be continued for any lengthened period, the insulation of the armature coils would be in great danger of being destroyed.

One method of mitigating this evil was to construct the machine of smaller dimensions, so as to afford greater facilities for the dissipation of the heat by radiation and conduction. But even in the smaller machines an inconvenient residuum of heat still remained when the machines were worked continuously for a considerable time, such as to render it desirable to adopt some means for abstracting the heat more rapidly. By means of a current of water circulating in the hollow brass segments which form part of the magnet-cylinder, Mr. Charles E. Ryder, the skilful manager at the works of Messrs. Elkington and Co., has happily succeeded in so far reducing this heating so as to permit of the machines being worked for days and nights together without intermission, and without any sensible diminution of the power of the current.

The machines which have been found to be the most efficient and economical in their working are those which have armatures from 3½in. to 4in. in diameter. The armatures are driven at about 2,000 revolutions per minute, and the water, after having passed through the magnet-cylinder, is used for supplying the boilers which furnish the power for driving the machines.

I have already shown elsewhere that the current from a small magneto-electric or electro-magnetic machine is sufficient to excite the great electro-magnet of the 10in. machine; and it has been further found, by my friend Mr. G. C. Lowe, that the current from one small machine is sufficient to excite simultaneously the electro-magnets of several small machines. In a number of 3½in. machines which have been constructed under my direction for Messrs. Elkington and Co. for the electro-deposition of copper on a large scale, the currents from two 3½in. electro-magnetic machines are made to excite the electro-magnets of twenty similar-sized machines to a degree sufficient to bring out the maximum dynamic effect of each machine. The electro-magnets of the two 3½in. exciting machines are charged by the current from a small 2½in. magneto-electric machine; but I have found that nearly as good a result may be obtained from the twenty machines by dispensing with the small magneto-electric machine, and employing the residual magnetism of the two 3½in. exciting machines in a manner similar to that described, almost simultaneously, by Mr. Farmer,* Messrs. Varley,† Mr. Siemens,‡ and Sir Charles Wheatstone.§

So far I have adverted principally to the means by which a very serious defect in the practical working of the new induction machine was remedied, a defect which many of my friends, who were unacquainted with the efforts which have been made to overcome it, have considered to be fatal to the success of what seemed likely to be a useful invention. But while the difficulty arising from the heating was now obviated, the subdivision of the materials of one large machine into a number of small ones gave rise to another defect which it was also found necessary to overcome; for although the armatures of several machines might be driven nominally at the same speed from the same driving-shaft, by means of straps, yet when the combined direct current from several commutators was required, the want of perfect synchronism in the revolution of the armatures operated to produce a diversion of the currents of some of them through the coils of others, which were at the neutral point of their revolution; and consequently the maximum useful effect of the combined currents could not be obtained.

As the high speed at which the machines were driven precluded the employment of toothed gearing, the only method which seemed at all feasible for producing the requisite synchronism of the armatures was to place a number of the machines in a straight line, and connect them together by means of a clutch fixed on the end of each armature-spindle. The chief objection to the carrying out of this arrangement was the difficulty of providing the requisite means for preserving the synchronism of the system, when any of the intermediate machines were disabled by accident, or stopped for repairs, so that practically it would not have been found convenient to work more than two machines geared together in the manner described.

It was while experimenting with a pair of machines so geared together that I first observed the phenomenon which forms the subject of this communication. These machines were arranged for producing the electric light, with a view to their application to lighthouse illumination. The armatures were 4in. in diameter, and each of them was coiled with a copper wire conductor 280ft. long and ⅛ of an inch in diameter. The currents were taken from the armatures by means of copper brushes rubbing against metal rings connected respectively with the ends of the armature coils, and were therefore in alternate directions. It has been found that alternating currents are much better adapted for the production of a constant electric light at a fixed point in space than the current which has been rectified by means of a commutator.

The clutch, by which the armatures were connected, consisted of two iron discs about 4in. in diameter, having, in the face of one, two iron pins which could be guided into two corresponding holes in the face of the other. These discs could be engaged or disengaged either when the machines were at rest or in motion. The relative positions of the pins and holes in the discs were such that the armatures might be engaged in reversed positions of half a revolution when required.

Each of these 4in. machines, when making about 2,000 revolutions per minute, was of itself capable of producing a very efficient electric light; and when the two armatures were clutched together in such a position that the united positive currents from both machines proceeded from one polar terminal simultaneously with the united negative currents from the other polar terminal, the sum of the currents of the two machines was obtained. On the other hand, when the armatures were clutched together in the reverse position without any change being made in the armature connections, no current was produced outside the two machines.

These experiments, besides exhibiting the necessity of synchronous rotation, further showed that the armatures must also occupy the same relative position in the magnet-cylinders in order that the combined current from the two machines might be obtained. It now occurred to me to see to what extent the want of synchronism in the armatures would affect the magnitude of the current. The armatures were therefore unclutched and allowed to revolve independently of each other, in the same manner as when the attempt was made to take the combined *direct* current from the

* Read at a meeting of the Literary and Philosophical Society of Manchester, December 15, 1868.

† *Phil. Mag.*, s. 3, Vol. XXIII., p. 264.

* Letter to the Author, November 9, 1866, Salem, Mass., U.S., *Proceedings* of the Literary and Philosophical Society of Manchester, February 19, 1867.

† Specification filed at the Office of the Commissioner of Patents, December 24, 1866.

‡ Specification filed at the Office of the Commissioner of Patents, January 31, 1867.

§ *Proceedings* of the Royal Society, February 14, 1867.

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commutators. After the *alternating* current had been transmitted through the electric lamp for some time, I was surprised to find that there was no perceptible diminution in the amount of light produced from the carbon points, and that the current would melt very nearly the same quantity of iron wire as when the armatures were clutched together. On examining into the circumstances attending this unexpected phenomenon, I first observed that, whenever the machines were stopped, the pins and holes in the respective discs were exactly opposite each other, and that, while the armatures were revolving, the two discs could at all times be engaged and disengaged with the greatest facility. Moreover, even when before starting the machine the discs were set a quarter or half a revolution out of the position in which the maximum amount of current was obtained, it was found that, after the armatures had been revolving for a few moments, the discs resumed their normal position with respect to each other (as indicated by the action of the clutch)—thereby exhibiting not only the synchronous rotation of the armatures, but also that the machines contained a principle of self-adjustment to the position in which the maximum effect of the combined current was obtained. It will therefore be evident that this property of the current, to maintain the synchronism of the armatures, renders it unnecessary to employ mechanical gearing of any kind for that purpose.

Proceeding further in this investigation, I found that, in order to produce synchronous rotation, it was not at all essential that the circuit which conveyed the combined currents for producing the light should be completed, provided that the ends of the coils of each armature were connected respectively with the same metal plates which formed the polar terminals of the machines. In this case the armatures adjusted themselves to their normal positions even more readily than when the current was producing the light. The accompanying diagram will assist in explaining these observations more fully.

Let D and D represent the two armature-coils, which, though each 280ft. long, may virtually be represented by a single turn; E E the two outer extremities of the coils, both connected by means of the metal rings and brushes with the metal terminal plate F; G G the inner extremities of the same coils, similarly connected with the terminal plate H. The synchronous rotation of the armatures and coils D and D, as I have said, occurs either when the light is produced by the combined currents transmitted from the polar terminals F and H, or when the circuit which conveyed these combined currents is broken.

The synchronism, however, is no longer preserved when a short circuit is made between the terminals F and H by substituting a good conductor for the carbon points, or for the long piece of iron wire which was melted. Nor, again, was this synchronism preserved when contact between the metal plate H and one of the ends, G, of the coil was broken. In the latter case it was observed that, whenever contact between G and H was made and broken, a bright spark appeared at the point of disjunction so long as the rotation was not synchronous; but when the synchronism was reestablished, only a trifling residual spark was visible.

Although the synchronous rotation was preserved when the terminals F H, from which the combined current was transmitted, were disconnected from the electric lamp, yet it will be seen, from an inspection of the diagram, that a complete metallic circuit was in fact always formed between these terminals through the coils themselves. Now, when the coils D D happen to be at the same moment in that position during their revolution in which they are producing the maximum and minimum amount of current respectively, as must often be the case where there is no synchronism, that current which is at the maximum rushes through the coil which is producing the minimum current, as is shown by the spark at the point where contact is broken between G and H. The effect of this passage of the current from one coil to the other is to accelerate or retard the rotation of the armature (according to the direction of the current) until synchronism is established.

That this influence of one coil upon the other operates in the manner described was easily shown by the following experiment:—The driving-strap of one of the armatures was removed, so that only one of the armatures should be producing a current, while the magnetism of the electro-magnets of both machines was, as usual, maintained to the same degree. On placing the stationary armature with its coil in a suitable position in relation to the magnet-cylinder for producing electro-magnetic rotation, and setting the other armature in motion, the stationary armature with its coil oscillated rapidly in arcs of very small amplitude, the oscillations corresponding in number with the alternations of the current. As the amplitude of the oscillations in this experiment was limited by the *vis inertiæ* of the armature, and in order that the effect of one pulsation only on the armature might be observed, contact was made and broken suddenly between the plate H and the end G of the coil by a sort of tapping motion, when the stationary armature was suddenly jerked round nearly a quarter of a revolution, sometimes in the direction in which it would have been driven by the strap, and at other times in the opposite direction, according as the alternating electrical wave which happened to be passing at the instant of making contact was positive or negative.

We have now seen, in the results obtained with the rotating and stationary armatures, a cause sufficient to account for their synchronism when revolving together—the absence of synchronism observed when the terminals F and H were bridged over by a conductor having comparatively little or no resistance being occasioned by the controlling current traversing the short circuit established between the terminals F and H, instead of the 280 feet of resistance presented by either of the coils when approaching the neutral point of their revolution. The absence of synchronism observed when the direct current was taken from the machines by means of commutators, is caused by the direction of the current being coincident with that which they would receive by induction from the electro-magnets, and consequently opposite to that which tends to impart an accelerating or retarding impulse to the armatures.

Having obtained the full effect of the combined alternating currents from the two machines without any mechanical gearing, it yet remained to obtain the combined direct currents from the machines in the same manner. A pair of rings and a commutator were therefore fitted upon one of the armature-spindles, which was made sufficiently long for the purpose, and metallic connection was established between the rings of each machine and the commutator on the prolongation of the armature-axis. As the commutator necessarily revolved synchronously with the two armatures, it was found that the combined alternating currents were rectified just as if they had proceeded from only one machine, and were consequently available for electro-deposition, or for any other purpose for which a direct current might be required.

Although this property of synchronous rotation has as yet been observed only in the case of several pairs and a triple combination of machines, yet there is no reason for supposing that it may not be extended to any number of machines that may be conveniently worked together from the same prime mover. It is necessary, however, to observe that as the controlling power of the current is only calculated to correct such minute deviations from synchronism as it is beyond the power of mechanical skill to prevent, the driving and driven pulleys should be respectively as nearly as possible of the same diameters, as the correction of any considerable difference in the number of the revolutions of the armatures, caused by differences in the diameter of the pulleys, must necessarily be attended by a corresponding diminution of the useful effect of the current outside the machines.

Before concluding this communication I wish to direct attention to an important property of the magneto-electric circuit which renders the commonly accepted theory, by which the generation and propagation of the electric influence in voltaic circuits is explained, inapplicable to those circuits which are entirely metallic. Reference to this property is all the more called for at the present time, as I find that a want of acquaintance with it has given rise to no small amount of misconception on the part of several eminent mathematicians and electricians who have examined my experiments on the electric condition of the earth, and the method by which I have thought proper to estimate the magnitude of powerful induction currents*.

The intensity of a voltaic current, as represented by the mathematical theory of Ohm, is equal to the electromotive force divided by the internal resistance of the battery; and from this theory it is inferred that an electro-motor, in order to overcome a great external resistance, must itself possess a correspondingly great internal resistance. A further consequence deduced from this theory is that the maximum useful effect of a given electro-motor is obtained when the external and internal resistances are equal.

Now, this mode of estimating the magnitude of an electric current does not apply to the circuits on the armatures of my machines. Taking for example the results obtained from the quantity armature of a 10in. machine:—The dimensions of the coil of this armature may be represented by a bar of pure copper, 67ft. long, and having a sectional area of 1·6 square inch; so that the resistance which this circuit presents to the passage of a current, when compared with that of the liquids in a voltaic battery, is practically null. When the coil is in full action it will melt 15in. of thin iron wire ·035 of an inch in diameter, or the same length of ¼in. iron rod with equal certainty, and will electrolyse acidulated water in at least 16 voltameters in series; so that the resistance outside the circuit, whether estimated by the 15in. of thin wire melted or by the number of electrolysing-cells in series, is more than a hundred times as great as that of the coil in which the current is generated.

Moreover I have found that whenever a voltaic battery and a magneto-electric machine will melt an equal length of wire, the power which these electro-motors have to overcome external resistance, as measured by the number of voltameters in series, is also equal. And, generally, the power of an electro-motor (whether voltaic or magneto-electric) to overcome external resistance is directly proportionate to the length of wire which it will melt.

From a consideration of these results, it will be seen that one of the fundamental elements which enters into the theory of Ohm is found wanting when that theory is applied to the estimation of the magnitude of currents generated in circuits entirely metallic.

MM. Jamin and Roger, in a recent number of the *Comptes Rendus* of the Academy of Sciences†, have also pointed out the discrepancy here referred to in the application of Ohm's theory to magneto-electric circuits. I am, however, by no means prepared to admit the correctness of the views advanced by these physicists in their endeavours to reconcile the facts observed with established theory; besides which, other anomalies present themselves when the customary formulæ are applied to magneto-electric circuits, a consideration of which must ultimately lead to the enunciation of laws much more general in their application than those with which we are at present familiar.

P.S.—Since this paper was read it has occurred to me that a comparison might be attempted to be drawn between the controlling power of the magneto-electric current over the rotations of a number of armatures, and that of the voltaic current over the oscillations of a number of pendulums. Beyond the fact that synchronism is produced in both cases through the agency of an electric current, there is no further resemblance

* *Philosophical Magazine*, August, 1868. † *Ibid*, October, 1868.

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between the two actions. In the case of the armatures the synchronism is produced by the mutual action of several rotating bodies upon one another, or by the dominant influence of several bodies upon one; whereas in the case of the pendulums the synchronism of the system is produced by the influence of one body alone upon several. Again, the synchronism of a number of pendulums is only accomplished by the skilful adaptation of means to an end, while the synchronous rotation of a number of armatures is a phenomenon which exhibits itself without the exercise of any ingenuity whatever; and, so far as I have studied this peculiar electro-mechanical action, no amount of ingenuity can produce the synchronous rotation of the armatures by means of the voltaic current, as magneto-electric currents and circuits seem absolutely essential to the attainment of this result.

ON THE INFLUENCE OF CENTRIFUGAL FORCE ON HIGH SPEED BELTING.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 15.)

It is interesting to note that size of pulley and speed are inversely proportional; thus, if at 1,000 revolutions a 16in. pulley is the best size to transmit a certain power with a given belt, at 2,000 revolutions the same belt would transmit the same power best, if used with an 8in. pulley. In fact, the most advantageous belt speed is a constant for each case. It should also be noted that $R\,n$ (the belt speed) remains unaffected by proportionate changes in the power transmitted and the size of belt. That is to say, if we wish to transmit twice the power we would employ a belt twice as wide or twice as thick, but we would not alter the belt speed—this remains the most advantageous one as long as the cross sectional area of the belt is varied in proportion to the power transmitted. By inserting the above value for R into the formulæ for T_0 and β we find

$$T_0 = (2\epsilon\gamma)^{\frac{1}{3}} (\kappa\eta\,H.P.)^{\frac{2}{3}}$$

and β exactly half that value. The calculation need not be gone through here, but we note the result. The smallest possible strain in the driving side of a belt is therefore

$$T\,min. = 1{\cdot}5\,(2\epsilon\gamma)^{\frac{1}{3}} (\kappa\eta\,H.P.)^{\frac{2}{3}};$$

or, if we insert the numerical values for ϵ and η, and neglect fractions,

$$T\,min. = 39\,\sqrt[3]{\gamma\,\kappa^2\,H.P.^2}.$$

This formula is applicable in all cases where the size of the belt, and consequently its weight γ per foot run are determined beforehand, but it cannot be used for finding the size of the belt at one operation.

The size of the belt to be used for any given case depends on the amount of tension we allow per square inch of cross section. Let this be σ pounds, and let the area of cross section in square inches be a, then

$$T\,min. = \sigma\,a.$$

Since γ depends on the cross-sectional area, and since that is not known beforehand, it will be convenient to substitute another expression for it, viz.,

$$\gamma = \frac{a\,\delta}{144},$$

where δ is the weight of one cubic foot of belt in pounds. By introducing these values into the above equation for the minimum strain and again neglecting fractions we obtain an expression for the least possible area of cross section of belt in square inches.

$$a = 21\,\kappa\,H.P.\sqrt{\frac{\delta}{\sigma^3}}$$

It must be borne in mind that this minimum of area can only be used on condition that the belt is caused to run at the most advantageous speed as given by the formula for $R\,n$; at any other speed the area would have to be greater. By inserting the values for $\epsilon\,\eta$ and γ into the formula for $R\,n$, and again neglecting fractions we find

$$R\,n = 375\sqrt{\frac{\sigma}{\delta}};$$

and since $2\,\pi\,R\,n$ is the speed of the belt in feet per minute, we have

$$\text{belt speed} = 2{,}350\sqrt{\frac{\sigma}{\delta}}.$$

From this it will be seen that the most advantageous belt speed is independent of the horse-power transmitted, of the coefficient of friction, of the arc spanned, and of the size of the belt. It depends only on the proportion between the specific gravity of the belt and the working strain per square inch. This is a very remarkable result, but quite consistent with experience. Practical men have settled long since that ordinary single-leather belting, if driving high speed machinery, should run at speeds varying between 3,000ft. and 6,000ft., the choice of any definite speed between these limits being more a matter of convenience than anything else. To test our formula by the light of practical experience we will calculate the best speed for an ordinary case. The weight of one cubic foot of belting can be taken as 69lbs., the working strain should not exceed 300lbs., say we fix σ at 280lbs. per square inch. The best speed is then $2{,}350\sqrt{\frac{280}{69}} = 4{,}730$ft. per minute, therefore within the limits fixed by practice. If instead of single belting we had to do with double belting, we should have to put $\sigma = 200$ pounds, and the best belt speed would be about 4,000 feet a minute. Here we see how theory confirms the old experience known to every millwright, that double belts should not run at so high a speed as single belts.

To make the present investigation of some use for the design of belts and pulleys, it will be necessary to repeat here a few of the simple formulæ above obtained. Generally speaking one of the two following problems presents itself. Either all the data are given and the working strain per square inch of belt is to be determined, or only the horse-power to be transmitted and the number of revolutions are given and the other data are to be found.

In the first case we find the tension in the tight side of the belt in pounds

$$T = \frac{\kappa\,5{,}250\,H.P.}{n\,R} + {\cdot}000344\,\gamma\,R^2\,n^2,$$

and the corresponding working strain per square inch

$$\sigma = \frac{T}{a}.$$

In the second case we would first determine the most advantageous belt speed in feet per minute by using the formula

$$2\,\pi\,R\,n = 2{,}350\sqrt{\frac{\sigma}{\delta}},$$

and from this we obtain the diameter of the pulley, since the number of revolutions is known.

As regards the area of belt section it is customary in low-speed belting to add about 10 per cent. to the tension in the tight side, as given by the formula, and to determine the area with reference to this increased figure. This is done to provide against an error due to uncertainty in the coefficient of friction, and since this uncertainty exists equally in the case of high-speed belting it will be best to allow 10 per cent. also in this case. In addition to this we must allow something for a variation in speed. It may not always be possible to run a belt exactly at the best speed. Existing pulleys might have to be used, or the governor of the engine may not allow the speed to be attained with mathematical precision. To provide for these cases 5 per cent. extra area would probably be sufficient. Adding then 15 per cent. in all as a safe margin we find the cross-sectional area of the belt. It is

$$a = 24\,\kappa\,H.P.\sqrt{\frac{\delta}{\sigma^3}}$$

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Example.—A dynamo requiring 30 horse-power in the belt is to be driven at 900 revolutions per minute. We allow a working strain of $\sigma = 250$lb., and the weight of one cubic foot of belting is 69lb.

$$2\pi 900 R = 2{,}350\sqrt{\frac{250}{69}} = 4{,}450\text{ft.}$$

From this we find the diameter of pulley to be 19″. If the belt spans 0·45 of the circumference, and the coefficient of friction be taken at 0·29, a figure which is correct for moderately greasy belts on iron pulleys, we find $\kappa = 1{\cdot}83$, and $a = 2{\cdot}75$ square inches. To obtain this area with a single belt it would have to be between eight and nine inches wide and between $\frac{3}{8}$in. and $\frac{5}{16}$in. thick. The strain in the driving side would be about 600lb.; of this force 400lb. would be required to transmit the power by means of a weightless belt, whilst the remaining 200lb. counteract the effect of centrifugal force.

THE THEORY OF ALTERNATING CURRENTS.*

BY J. HOPKINSON, F.R.S.

(CONTINUED FROM PAGE 13.)

III. *Suppose the terminals of an alternate-current machine are connected to a pair of conductors, the difference of potential between which is completely controlled by connection with other alternate-current machines.*

Let γ and R be the coefficient of self-induction and the resistance of the machine and its own conductors up to the point at which the potential is completely controlled. Let the difference of potential of the main conductors be $A \sin. \frac{2\pi t}{T}$, and let the electromotive force of the machine be $B \sin. \frac{2\pi(t-\tau)}{T}$.

Equation of motion is

$$\gamma x' + R x = B \sin. \frac{2\pi(t-\tau)}{T} - A \sin. \frac{2\pi t}{T},$$

whence

$$x = \frac{1}{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left[B\left\{R \sin. \frac{2\pi(t-\tau)}{T} - \frac{2\pi\gamma}{T} \cos. \frac{2\pi(t-\tau)}{T}\right\} - A\left\{R \sin. \frac{2\pi t}{T} - \frac{2\pi\gamma}{T} \cos. \frac{2\pi t}{T}\right\}\right]$$

electrical work done by the machine in unit of time

$$= x B \sin. \frac{2\pi(t-\tau)}{T}$$

$$= \frac{1}{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2}\left[\frac{B^2 R}{2} - \frac{AB}{2}\left\{R \cos. \frac{2\pi\tau}{T} + \frac{2\pi\gamma}{T} \sin. \frac{2\pi\tau}{T}\right\}\right]$$

if τ be positive, that is, if machine be lagging in its phase, work done is less than if it be negative; hence τ will tend to zero, or the machine will tend to adjust itself to add its currents to that of the system of conductors. The machine may act as a motor *even though its electromotive force be greater than that of the system*, for let

$$\frac{R}{\frac{2\pi\gamma}{T}} = \tan. \frac{2\pi\phi}{T},$$

work (electric) done by machine

$$= \frac{B^2 R}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}} - \frac{AB}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}} \sin. \frac{2\pi(\phi+\tau)}{T}$$

This has a minimum value when $\phi + \tau = \frac{T}{4}$, and then the mechanical work done by machine or electrical work received by the machine

$$= \frac{B}{2\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}\left\{A - \frac{RB}{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}\right\}$$

and this is positive provided

$$\frac{A}{B} > \frac{R}{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}^{\frac{1}{2}}}$$

There are two or three other problems of sufficient interest to make it worth while giving them here, although not directly relating to alternate current machines coupled together.

IV. *To determine the law of an alternate current through an electric arc.*

It has been shown by Joubert that in an arc the difference of potential is of approximately constant numerical value, reversing its value discontinuously with the reversal of the current, probably at the instant of reversal of current. We shall assume, then, that there is in the arc a constant electromotive force, A, always opposed to the current, except when the current ceases, and that then its value is zero.

The equation of motion is

$$\gamma x' + R x = E \sin. \frac{2\pi t}{T} \mp A$$

the negative sign being taken when x is $+\infty$, the positive when x is negative. Solving generally

$$x = \mp\frac{A}{R} + \frac{E}{\left(\frac{2\pi\gamma}{T}\right)^2 + R^2}\left(-\frac{2\pi\gamma}{T} \cos. \frac{2\pi t}{T} + R \sin. \frac{2\pi t}{T}\right) + C e^{-\frac{R}{\gamma}t},$$

this equation will continuously hold good for a half period from $x = 0$ to $x = 0$ again, but at each half period the arbitrary constant C is changed with the sudden change of sign of A. It is determined by the consideration that if, for a certain value t_0 of t, x should vanish, it shall vanish again when $t = t_0 + \frac{T}{2}$. This applies to the case when E is sufficiently large, as is practically the case, but if the current should cease for a finite time this condition will be varied, and instead of it we have the condition $x = 0$ when $E \sin. \frac{2\pi t}{T} = A$. This latter case I do not propose to consider further.

Let $$\frac{2\pi\gamma}{RT} = \tan. \frac{2\pi t_1}{T}$$

$$x = \mp\frac{A}{R} + \frac{E}{\sqrt{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}}} \sin. \frac{2\pi(t-t_1)}{T} + C e^{-\frac{R}{\gamma}t}$$

putting $t = t_0$ and $t = t_0 + \frac{T}{2}$ we have

$$0 = -\frac{A}{R} + \frac{E}{\sqrt{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}}} \sin. \frac{2\pi(t_0 - t_1)}{T} + C e^{-\frac{R}{\gamma}t_0}$$

$$0 = -\frac{A}{R} - \frac{E}{\sqrt{\left\{R^2 + \left(\frac{2\pi\gamma}{T}\right)^2\right\}}} \sin. \frac{2\pi\gamma(t_0 - t_1)}{T} + C e^{-\frac{R}{\gamma}t_0} \cdot e^{-\frac{RT}{2\gamma}},$$

equations to determine t_0 and C.

* Paper read before the Society of Telegraph Engineers and Electricians on November 13th.

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Eliminating C,

$$\frac{RE}{A\sqrt{\left\{R^2+\left(\frac{2\pi\gamma}{T}\right)^2\right\}}}\cdot\sin.\frac{2\pi(t_0-t_1)}{T}=-\tanh.\frac{RT}{4\gamma}.$$

Having obtained t_0, C is given by equation

$$\frac{2A}{R}=Ce^{-\frac{R}{\gamma}t_0}\left(1+e^{-\frac{R}{2\gamma}T}\right).$$

This gives the complete solution of the problem.

A case of special importance is that in which R is small; let us therefore consider the case R = 0, the solution then is

$$\gamma x=-\frac{T}{2\pi}E\cos.\frac{2\pi t}{T}-At+C.$$

In the same was as before

$$E\cos.\frac{2\pi t_0}{T}=\frac{A\pi}{2},$$

$$C=A\left(t_0+\frac{T}{4}\right).$$

The limiting case to which the solut ion applies is given by $x'=0$ when $t=t_0+\frac{T}{2}$.

$$E\sin.\frac{2\pi t_0}{T}=A,$$

whence $$E^2=A^2\left(1+\frac{\pi^2}{4}\right),$$

or $$A=E\times 0{\cdot}538.$$

Roughly, we may say that, in order that the current may not cease for a finite time, E *must be at least double of* A; A will of course depend upon the length of the arc. The work done in the arc will be proportional to the arithmetical mean value of the current taken with regard to sign. This is of course quite a different thing from the mean current as measured by an electro dynamometer. Let us examine what error is caused by estimating the work done in the arc as equal to the current measured by the dynamometer multiplied by the mean difference of potential.

The actual work done per second

$$=\frac{2A}{T}\int_{t_0}^{t_0+\frac{T}{2}}x\,dt$$

$$=\frac{2A}{\pi\gamma}\cdot\frac{T}{2\pi}\cdot\sqrt{E^2-\frac{\pi^2A^2}{4}}.$$

The mean square of the current, as measured by the electro-dynamometer is

$$\frac{2}{T}\int_{t_0}^{t_0+\frac{T}{2}}x^2dt=\frac{T}{2\pi\gamma}^2\left\{\frac{E^2}{2}-2A^2\right\}+\frac{A^2T^2}{48\gamma^2}$$

and the work done by this current is apparently the square root of the above expression multiplied by A. It is easy to see that this is greater in all cases than the work done, but it is worth while to examine the extent of the error. If we treated the arc as an ordinary resistance, we should assume work per second

$$=\frac{A}{\gamma}\sqrt{\left(\frac{T}{2\pi}\right)^2\left(\frac{E^2}{2}-2A^2\right)+\frac{A^2T^2}{48}}$$

Taking a fairly practical case, assume $A=\frac{2}{5}E$, we have actual work per second

$$=\frac{A^2T}{\gamma}\cdot\frac{1}{\pi^2}\sqrt{\frac{25}{4}-\frac{\pi^2}{4}}$$

$$=\frac{A^2}{\gamma}T\frac{\sqrt{15}}{20}\text{ nearly,}$$

work done estimated by electro-dynamometer

$$=\frac{A^2T}{\gamma}\sqrt{\frac{1}{40}\left(\frac{1}{2}\frac{25}{4}-2\right)+\frac{1}{48}}\text{ nearly}$$

$$=\frac{A^2T}{\gamma}\frac{1}{20}\sqrt{\frac{235}{12}}$$

or nearly $\frac{1}{6}$ part too much. This will suffice to show that the matter is not a mere theoretical refinement. Another erroneous method of estimating the power developed in an arc is, to replace by a resistance and adjust this resistance till the current, as measured by an electro-dynamometer, is the same as with the arc, and assume that the work done in the resistance is the same as the work done in the arc.

Returning to the expression

$$\frac{2A}{\pi\gamma}\cdot\frac{T}{2\pi}\sqrt{E^2-\frac{\pi^2A^2}{4}}$$

we may inquire, given T A and the dimensions of the machine, how ought it to be wound or its coils connected that most work may be done in the arc? If the number of convolutions be varied, E will vary as the convolutions, γ as their square, therefore $\gamma\propto E^2$; we are therefore to determine E so that $\frac{1}{E^2}\sqrt{E^2-\frac{\pi^2A^2}{4}}$ is a maximum which occurs when $E=\pi A$. When the resistance of the circuit is taken into account this result will be modified. It suffices to prove that it is desirable that the potential of the machine should be materially in excess of that required to maintain the arc.

(TO BE CONTINUED.)

TROUVE'S PORTABLE LAMPS.

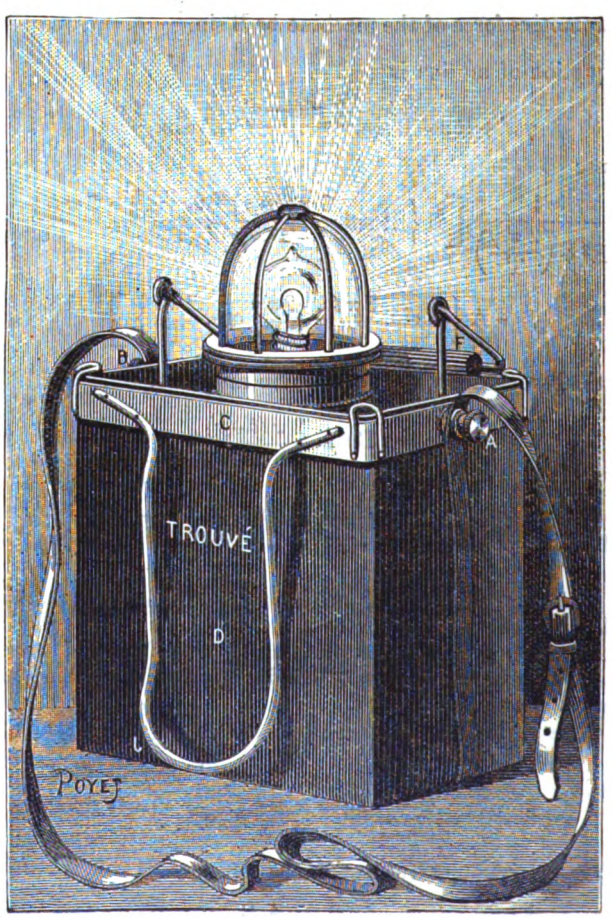

FIG. 1.

In consequence of several accidents which have lately occurred at Paris, due to escapes of gas, forming with the air an explosive mixture, lighted inadvertently or carelessly, a special committee was

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appointed to study the question. This committee finally adopted the lamp invented by M. Gustave Trouvé, of Paris, which has lately been described to the Société Technique du Gaz, and was on the 3rd inst. brought by M. Jules Jamin before the Académie des Sciences.

The leading principle of this portable apparatus, which is illustrated below, is that the current is sent through the carbon filament of the incandescent lamp by the immersion of the carbon plates of the battery in the exciting solution, while the light ceases on the interruption by their withdrawal; and this immersion is brought about by the mere placing of the lantern in the position in which it is required for use, the withdrawal being effected automatically by its removal from that position. It follows that the energy of the battery is only expended while the lamp is actually incandescent, and that no danger is to be feared, in an explosive mixture, for use in which the lamp is primarily destined, by sparks produced by the action of any commutator for making and breaking contact. Moreover, in some varieties of the lamp, intended for domestic use, the intensity of the light may be regulated by the degree of immersion of the carbons.

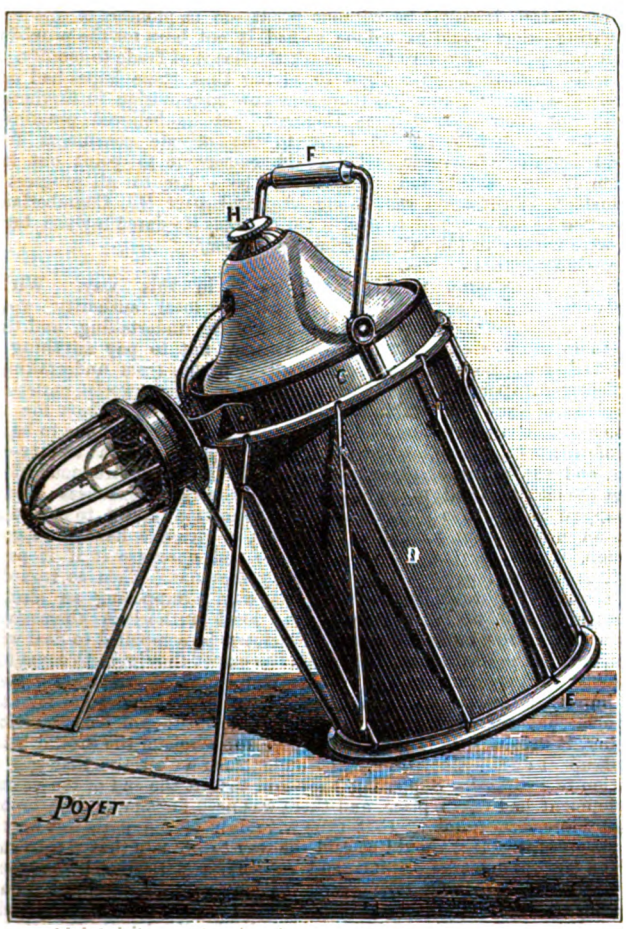

FIG. 2.

Fig. 1 shows a portable form of battery, and lamp combined, the latter becoming incandescent on the apparatus being set down, but not so when hung over the shoulder by the strap, carried by the handle F, or suspended by the hook J, attached to the ring C encircling the case D. In another form, the converse takes place; that is to say, the lamp becomes incandescent when carried, but not when set down; or again, when suspended, but not when carried or set down. When these lamps are supplied to firemen or gasmen, they are so arranged that, on an alarm being raised, each man takes up his lamp and carries it, thus keeping the carbons out of the solution. Arrived at the spot where he may have to enter a room with an explosive mixture, he hangs the apparatus over his shoulder, and thus allows the carbons to descend into the solution, turning on the light but leaving both hands free.

Figs. 2 and 3 show the incandescent lamp fixed to the side of the ring C surrounding the upper portion of the battery case D. When the apparatus is set down, it rests upon the plate G, which, attached to the cover, by a rod passing through the middle, lifts the carbons out of the solution. But when the apparatus is carried by the handle F, the weight of the plate G and of the cover and carbons keeps the latter immersed; and the lamp shines forth. The milled head H of a quick-threaded screw is for regulating the light by giving the carbons more or less immersion. Ribs and struts, like those of an umbrella, are loosely jointed to the rings C and E of this the domestic form of lantern, so as to hold it in the posision shown at Fig. 2, if in danger of being overturned.

All the varieties may readily be taken to pieces for cleaning: that shown in Fig. 1 by removing the two screws A and B, which allow the ring C to be taken off, thus releasing the carbons contained in the case D; and that shown in Figs. 2 and 3, by springing off the handle F, when the ribs and struts may be removed from the case. In both varieties the case is then free from all metal parts, and may be washed. The current is produced by a Trouvé battery, containing a saturated solution of bichromate of potash, such as that brought before the Académie des Sciences by M. Du Moncel, in March, 1883. The cover carries the carbons and the incandescent lamp, which, for preventing any chance of accident due to breakage is enclosed in a thick outer glass, that may contain water or any uninflammable and non-combustible gas, such as nitrogen. The

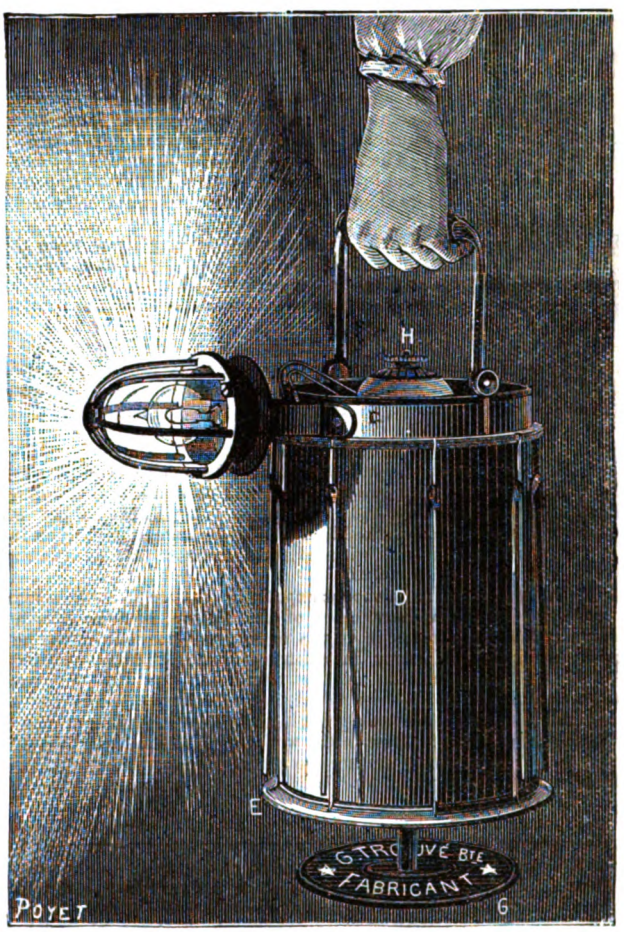

FIG. 3.

luminous intensity is that of four or five candles, or twelve to fifteen candles by combining two batteries with one suitable lamp; and the duration is about three hours of actual illumination.

These safe and portable lamps are useful for detecting leakages of gas, repairing gas mains and pipes, in fiery mines and distilleries—for all cases, in fact, where a light is necessary in a place where the atmosphere may be explosive. As a signal lamp that cannot be blown out, it should be invaluable on railways; while for domestic purposes it is always ready, consuming nothing until wanted, and dispensing with the searching for and striking of matches. Once more M. Trouvé has borne out his name and also his trade mark of εὕρηκα.

UTILISATION OF THE ISAR.—The Munich Electro-technic Commission has published a report on the utilisation of the power exerted by the River Isar. Of this power, estimated as being equal to that of 3,750 horses, it is proposed to retain 1,200 h.-p. for the electric lighting installations of the Municipality, and to let the remainder.

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MR. CHAMBERLAIN ON THE ELECTRIC LIGHTING ACT.

On Thursday an influential deputation representing all those interested in electric lighting had an interview with Mr. Chamberlain (with whom was Mr. John Holms, M.P., and Mr. Calcraft), at the Board of Trade. The deputation consisted of Lord Thurlow, the Chairman of the Anglo-American Brush Electric Light Corporation, Sir Fred. Bramwell, Mr. J. S. Forbes, Lord Anson, Mr. R. E. Crompton, Mr. Robert Hammond, Mr. Offor, Sir Daniel Cooper, Mr. T. H. Cothill, Major Flood Page, Mr. P. Cremieu-Javal, Dr. Farquharson, M.P., and others.

Lord THURLOW, having briefly introduced the deputation, handed to Mr. Chamberlain the main points on which the Company sought an amendment of the Act. They were as follow :—(1) That the rights given to local authorities to purchase compulsorily electric lighting undertakings within their districts upon the terms set forth in section 27 of the Electric Lighting Act were such as to prohibit any supply of the electric light to the public, and such clause should be repealed. [This clause gives local authorities the power to purchase compulsorily the enterprise at the then valuation at the end of 21 years.] (2) In the provisional orders granted by the Board of Trade, under the Act, the provisions as to the compulsory laying down of mains should be omitted ; and the undertakers should have the full power to decide as to the position and extent of the mains to be laid down by them, and the right to compel the undertakers to supply them with the electric light should be confined to consumers willing to take a minimum quantity per annum. (3) The undertakers should be permitted to supply otherwise than by meter, and in such cases the purposes to which electricity is applied by the consumers should be matter for agreement between them and the undertakers.

Mr. CHAMBERLAIN said he did not want to put any stress upon them, but unfortunately a Cabinet Council had been called that day, and it was then sitting, and he was anxious to get back to it as soon as possible, and they would therefore be kind enough to make their observations brief, at the same time making them clear.

Lord THURLOW explained that the deputation Mr. Chamberlain had been kind enough to receive might be considered as fairly representative of all the leading if not all the electric light companies, and they were all united in the views to be expressed that day. He thought Sir Frederick Bramwell was anxious to express their views at some length.

Sir F. BRAMWELL said Lord Thurlow had made a mistake. He was not anxious to do so, he was anxious for some one else to do it. But as he had been called upon he would do so, and he would bear in mind the intimation Mr. Chamberlain had given them. He felt the subject was a very important one, and he should have liked to have dilated upon it.

Mr. CHAMBERLAIN did not wish to press them to say less than what they thought was necessary.

Sir F. BRAMWELL said he should explain in what capacity he appeared before them. He was a shareholder of the Edison, now the Edison and Swan Company. He was in it at the outset, and to that extent he was certainly an interested party in electric lighting. Moreover, he was consulted by many persons at the time that the Bill was passing through committee, and he was asked to give evidence before the committee, and he did so. He took great interest in the passing of the Bill, and he had taken great interest in the working of the Act ever since, and in that way it was that he ventured to state to them what he believed to be the views of the deputation. With respect to the importance of the subject, he thought it was undoubtedly a most important one. It was an illuminant now well known by its application to steamboats, and by private installations and theatrical installations ; and he thought it was agreed that wherever electric lighting was to be obtained—the glow system of lighting for domestic purposes—that it gave an amount of satisfaction which had only to be tested to be appreciated, and it was a lighting, for various considerations, to be desired if within the reach of those who wished to have it. He thought on sanitary grounds, on the question of the diminution of heat and the non-vitiation of air, on the grounds of the preservation of pictures, and books, and furniture, and the non-dirtying of walls and ceilings—on all these grounds it was most desirable. The ability to go into a room at any time without seeking for a lamp, and to press a button and forthwith light up the whole room was in itself no small matter. But he did not want to go into those details, but would take it that they were perfectly convinced that electric lighting was a desirable thing, and that many persons would be willing to pay for it if they had the means of having it. It could be obtained, no doubt, by independent installations, and was so obtained by many ; but there were objections to that, and what they wished was that the inhabitants could have it in lieu of gas—have it laid into their houses as gas and water were. Again, it was important in another point. It must be agreed that during the last fifty years the material progress of the world had benefited by the application of science, and he did not know a more important application of science than that of electric lighting. It was considered years ago to be impossible to divide an electric current to get light from different lamps. The thing was now done. Well then, again, at the present time, unhappily, there was great depression in trade, and a considerable want of employment among the working classes. There they had he believed a new outlet for their capital which would be spent in giving orders to factories which now want orders and employ artisans sorely in need of work. That was an important thing. There was another point, and that was this—our coal supply was a thing that we ought to husband and take good care of. It was not a question of cost, but a question of using coal. Let him put it to them that coal burnt under a steam engine to work a dynamo would give the same amount of light as one-third or one-fourth of the coal that would be needed for the ordinary luminant gas. He was speaking when used with glow lamps. When used with arc lamps the same light would be obtained with one-twentieth of the coal. When there was half a ton of coal used per annum per head of the population it became serious. The return in round figures was that 2,140,000 tons of coal was burnt in the metropolis last year. Upon all these grounds one was entitled to say that this was a subject of very great importance indeed. Up to 1882 many persons had hoped there would be a very rapid development of this mode of supplying light, and it would be by the application of private capital for public purposes that this would be obtained. He entertained that hope, and became a shareholder of the Edison Company to the extent of £5,000. When he knew the provisions of the Bill he for one thought them to be calculated to defeat the object of those who wished to see electric lighting spread. He had stated his views to the Committee, and he did what he could after the Bill passed to get the terms altered, but with no success to speak of, and the Act remains with Clause 27 in it of which he had to speak. He was aware it was difficult to get capital into new undertakings, and to get persons to take up new sources of light when they had their houses already fitted with the plant necessary for gas ; but in spite of that he believed, if a sufficient number of men able and willing to embark their capital, and to urge the matter, it might be without profit—to be pioneers of this mode of lighting—they would have done so had it not been for the provisions of this Act, which they were there to ask the Board of Trade to modify. As it was, he thought he was right in saying that these hopes had been entirely disappointed, and that there was now no provision in England—he did not know absolutely in England, but he believed practically none—for the distribution of light to the private consumers from central sources of supply. He would endeavour to point out how Section 27 had acted and must act to be a bar to all progress in the matter. The section was a long one, and after Mr. Chamberlain's intimation he did not wish to read it *in extenso*. He dared say the terms of it were within his (Mr. Chamberlain's) memory.

Mr. CHAMBERLAIN : Yes.

Sir F. BRAMWELL would summarise it in this way. Within twenty-one years, or in a less period, the local authority would have the option of the compulsory purchase of the undertaking, and they were to do it upon certain terms. They were not to pay anything in respect of compulsory purchase or goodwill or profits from undertakings, but they were to pay the value of all such lands, buildings, works, materials, and plant of such undertaking suitable to and used by them for the purpose of t ier undertaking within such jurisdiction, such value to be, in case of difference, determined by arbitration. The period was twenty-one years, and the earlier of those years must be passed in strenuous efforts to get the electric light taken up so as to pay working expenses ; and it did appear to him that it was impossible to induce capital to come into such an undertaking, after all these years of struggle have been gone through, if the local authority can come and purchase it if it pays, and if it does not pay the local authority does not. Then as regarded the terms. He would put it in this way. Supposing an electric undertaking was made by one of the local authorities themselves, they would, in the interests of the ratepayers, be compelled to deal with the matter in the way he spoke of. From the outset they were to come to a particular arrangement, and experience had shown if that arrangement was improved they would discard the original arrangement and take the new one ; but the company would not get one shilling of compensation. Further, it involved, as it appeared to him, the whole of the capital being called up at once. They would not under such a clause as that get an addition to a capital. Supposing they said that at the end of ten years a development had taken place, and there was need for new capital, no one would subscribe capital at that time with only eleven years left for the enjoyment of it. If it should be said the way to obviate that was to subscribe a large amount of capital and call up a portion of it, he would reply that no one would take shares. People would not embark money upon such onerous conditions as those. Let them remember that under the conditions of certain clauses persons in the district were entitled to call upon the company to give a supply. It was true they were bound to guarantee for three years a certain amount of capital, but still it would necessitate the undertakers finding new plant at the time the requisition was made. That might have to be found shortly before the expiration of the period, and under the circumstances no one would embark capital ; and it appeared to them that Clause 27 was one absolutely prohibitory to getting capital invested in that kind of undertaking. He might ask was it not desirable that the public should have the power of having within their houses the luminant in the same way as they obtained gas? He trusted on consideration the Board of Trade would see their way to repeal so much of the Act as was embraced within Section 27. He could have spoken at much more length, but after the intimation from Mr. Chamberlain he did not think it right to do so, and he asked him to supplement what he had left out.

Mr. CHAMBERLAIN said he had had some correspondence with some of the companies, and he asked whether Sir F. Bramwell spoke for all present when he asked for the repeal of this clause, but in some of the letters he had had the companies wanted a modification.

Sir F. BRAMWELL could not answer that. It might be that there were persons who did not expect they would get a repeal, but he put it that that was the fair thing to do. He was quite sure those gentlemen who asked for a modification would be too glad to have the repeal.

Lord THURLOW said there had been a meeting of the companies yesterday, and they had decided to ask for the total repeal of the clause, in the hope of getting a modification (laughter).

Sir F. BRAMWELL said he asked in common justice for a total repeal

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of the clause in order that electric lighting should not be more heavily weighted than gas.

Mr. J. S. FORBES (the Chairman of the Edison and Swan Company) said those two companies had spent £380,000 in one way or another, and there was not only no return but there was not the remotest possible prospect of a return. He did not know what the Edison shares were worth, but the Swan shares, upon which £3 had been paid and on which £2 remained to be paid, he thought they would try and get something for taking them (laughter). They did not intend to go under that Act of Parliament, and they must at present give up all idea of public lighting. If Mr. Chamberlain wanted to kill electric lighting as applied to general lighting, then he would maintain the clause.

Mr. CROMPTON referred to Section 17 of Provisional Order for Redditch, which runs as follows:—"The undertakers shall within a period of two years after the commencement of this order lay down suitable and sufficient mains for the purpose of general supply upon the parallel system, in every street and part of a street specified in that part of Schedule A, and shall thereafter maintain the same." He said: It is my object, Sir, to point out to you that this obligation to lay mains over a fixed area has been a very principal bar to the carrying out of the provisional orders. Quite apart from the fact that the obtaining of these provisional orders being extremely costly, and is in itself a sufficient guarantee of the *bona fides* of the undertakers, I contend that this obligation entails a certainty of a heavy capital expenditure, which is extremely unlikely in the present state of the knowledge of the subject to prove remunerative. Since the passing of the Electric Lighting Act, and the granting of the Provisional Orders in the following year, our knowledge of the science of electric lighting has greatly advanced. We have had considerable experience in the fixing and working of detached sets of plant, but the fact that these sets of plants are detached, and that in this country, at all events, few or no public thoroughfares have had electric mains laid in them, has prevented us from increasing our stock and knowledge in the one respect which would have been of service to us in laying down these compulsory works in a satisfactory manner. There have been at least two modifications of the parallel system of main laying tried in America, and the data obtained have been very contradictory. Further, the conditions of supply in America differ from those in England, and at all events the American experience has so far been insufficient to enable us to choose a system of main laying which combines the three requirements of cheapness, efficiency, and durability. Thus far as to the laying of the mains themselves. Next, as to the districts in which the mains are to be laid. We find the very greatest difficulty in discovering who are likely to be our best customers in the future. In the case of provisional orders already granted, the obtaining of sites was of such paramount importance that the compulsory streets specified in Schedule A were chosen far more with regard to their nearness to the proposed site than with regard to their likelihood of furnishing a large percentage of paying customers. As time has gone on, it has been more and more forced upon us that the customers from whom we shall first obtain a revenue will be wealthy ones, and that they will be certainly for some time spread over a rather wide area. It follows that the obligation to spend a large portion of our capital in laying mains on certain fixed districts immediately contiguous to the supply station, and the hampering restriction as to extending these mains in any direction out of the A into the B district, will prevent us from laying the whole system in such manner as will give us the best chance of obtaining during the first few years of supply a remunerative return for our expenditure. Briefly, the two great objections to the laying down of compulsory works for electric mains are:—1st. That it would commit us to a large capital expenditure on a comparatively untried, and probably mechanically imperfect system; whereas at the beginning we wish to have the greatest possible scope to try several systems from which to choose the best to carry on our larger extensions, and that this compulsory laying on a considerable scale of what would very probably turn out to be a defective system would tend to increase the very evil from which the public are to be especially protected—viz., the frequent disturbance of the surface of the streets. 2nd. That the laying being made compulsory in certain fixed streets, or districts, is in all probability fatal to the chance of obtaining a remunerative revenue. I next beg to call your attention to the compulsory supply of electricity. Sec. 41 of the above Redditch Provisional Order, which states that the undertakers on being required so to do by the owner or occupier of any premises situate within twenty-five yards of the distributing main of the undertakers, shall give, and continue to give, a supply of electricity for such premises, subject to the provision of this order, and they shall furnish and lay any electric lines that may be necessary for the purpose of supplying the maximum current, &c. Now, Sir, I contend that this right to compel the undertakers to supply electricity should not be given to the consumers unless some adequate minimum of supply is fixed. As the section at present stands, the owner of a theatre, or any person giving any kind of exhibition or performance, requiring the use of a powerful light for a few minutes only during the whole 24 hours may compel the undertakers to furnish him with electricity sufficient for such display, and it is quite possible, and in fact very probable, to conceive a case where the capital cost to the undertakers of furnishing this supply for a few minutes per day may be thousands of pounds, as it would necessitate a large increase of the generating and distributing plant, whereas payment for this supply (being limited to the price obtainable under the order, viz., 8d. per unit as a maximum), might not exceed a few shillings. This is of course an extreme case, but the cases in which residents during a portion only of the year require a large supply of electricity during their shut term of residence in the district will be extremely common, and if any large number of such users have to be supplied it is certain that the undertaking will be rendered unremunerative. The experience gained during the last two years in working sets of detached plant has shown that the cases in which electricity has been produced most cheaply are those in which the hours have been long and the supply regular. I beg, therefore, to respectfully suggest that this section of the provisional orders should be amended by giving the right to compel the supply to such customers only as would use the light for at least 1,000 hours per annum.

Mr. HAMMOND also spoke.

Mr. CHAMBERLAIN said, in reply, that he was as anxious as the deputation for the development of this very important enterprise. He recognised the truth of all that Sir Frederick Bramwell had said on that part of the question, and if there was anything in the legislation of the past two years which unduly and unnecessarily interfered with it, he should be most happy to consider with them how that legislation was to be amended He understood their view to be put rather stongly before him that the small progress which had been made was entirely due to that legislation He did not want to enter upon contentious subjects, or he could argue that a little. He should say that in a great measure the failure to proceed more rapidly was owing to the haste on the part of companies which have been more or less financial speculations. A few years ago those companies came to Parliament and proposed practically to parcel out the whole of the kingdom among them at a time, according to the statements just made, when they knew so little of the matter that they did not know the best form for giving the supply; that they did not know the best form of dynamo; that what they purchased for £2,000 turned out a few months afterwards to be only worth £200; and generally the whole matter was in an empirical condition which could not form the basis for really sound commercial enterprise. Under such circumstances it seemed to him it was the duty of Parliament to prevent the appropriation of all the avenues to this great business by companies and individuals who were not really prepared to deal with it in a practical way. A Committee of the House of Commons was appointed for the purpose of considering the whole matter. He thought the Committee would be generally admitted to have been a very able and impartial committee, upon which all interests and a great deal of the existing knowledge was thoroughly represented. Mr. Stanhope was the chairman of that Committee, which came practically to a unanimous conclusion, and the Act now complained of was the result of its deliberations. What was the intention of the Committee in proposing the Bill, which was subsequently somewhat amended in the House of Lords, on the motion of Lord Bramwell and other gentlemen interested in the matter? The Bill, as it left the Commons, gave only fifteen years before the right of purchase arose; but in the House of Lords twenty-one years was substituted for the fifteen. The Committee's intention undoubtedly was to prevent the creation of those vast monopolies which in the case of gas and water had sprung up, and which were believed by at any rate the majority of the people to be on the whole inconsistent with the true advantage of the community. At the same time the object was not necessarily to interfere with the progress of this industry. Sir F. Bramwell said it was very hard that this business which comes into competition with gas should be subject to limitations which are not applied in the case of gas. But he omitted altogether to state that gas was under considerable limitations. In the case of gas there was no attempt made to prevent a monopoly; but there was an attempt made to limit the monopoly in the interest of the community by having limitations of dividends, which experience had shown did not work very well; but the object was the same in the case of gas as in the case of electricity, although it was sought to be obtained by different means. Several speakers had said there was no similar case of restrictions such as those which appeared in the Electric Lighting Bill. That was also a mistake, because there was precisely the same restriction in the case of tramways. With the same view in the Tramways Act there is a clause which enables the local authority to purchase at the expiry of twenty-one years. The object was exactly the same, even if the detail of the method be somewhat different. He would admit at once that if they were to discuss the methods they were fairly open to reconsideration. He should say that in the 27th clause the object of the Committee was that, while the community should be enabled to resume this monopoly at any moment after the twenty-one years, it should do so on terms which would at all events fairly recoup the undertakers for all legitimate outlay. It might be that the terms of that clause did not carry out that object, and if the deputation were of that opinion he could only say that if they would draw up such a modification of the clause as in their opinion would satisfy those conditions, he would take care that it had the fullest consideration. But he was bound to say frankly that he could not give any support whatever to a plain proposal that the whole of that clause should be repealed. He did not think that the local authorities of the country would assent to any proposition of that kind, and he could not think that Parliament, which had shown itself hostile to the creation of those great monopolies, would allow a new one in the case of electric lighting, unguarded by any such limitations as those which they had sought to impose. Some kind of limitation they must take to be an absolute necessity; and the only question to consider was whether the limitation imposed was a limitation which unfairly restricted the progress of the industry, and which therefore might be properly altered as to its details. There were a number of minor matters which he admitted were subjects for further consideration, and upon which he should be very glad to have any propositions from the deputation. In the first place, there was the question of compulsory supply to a district. Mr. Hammond said that the concession was not a monopoly. It was not a legal monopoly, but it was a practical monopoly, because there was no doubt that the Board of Trade would not grant an alternative concession except upon proof that the existing concessionaries were not properly performing their duty, or that some great improvement had been made, and that they were not satisfactorily dealing with the matter. Therefore it was a practical monopoly, and a practical monopoly must carry with it corresponding obligations. The obligations may be a little too stringent for the present condition of this invention. If so he

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should be glad to know the exact measure in which they wanted them modified. But to say that they should give to a company what was practically the absolute control of a large district without any obligation at all, enabling them to shut out other competitors who might be willing to do more, and to do nothing themselves, was a proposition which must not be entertained. Some kind of obligation there must be, and the question was to what extent it must go. The second point was that where mains are laid down they were under a condition to supply compulsorily all consumers. But they omitted to say that it was only under certain circumstances. That was of some importance, because the question had been brought before the Board as to whether it might not be desirable that supply should be given to certain *quasi* public institutions, like clubs and institutions of that kind, where a very large quantity would be taken without a necessary obligation to supply private consumers. There was nothing in the provisional orders which would prevent an arrangement of that kind. Neither was there anything in the Act or provisional orders which would prevent the differential price in favour of large consumers. That differential price existed no doubt in the case of gas, and he saw nothing unjust in it—nothing to prevent a similar arrangement in the case of electric lighting. Upon that matter, therefore, if any practical proposition were placed before the Board, they would be glad to facilitate the supply of electricity in particular cases without enforcing too stringent and too general an obligation. It was suggested they ought to have the right of compulsory acquisition of land for works. That appeared to be a perfectly reasonable application, and one he would be glad to give effect to. As to the delay in granting provisional orders, he might point out that a license could be obtained at almost a single notice.

Mr. HAMMOND: Only for seven years.

Mr. CHAMBERLAIN said that was so, but it would give them rights for the moment, and cover the period which would be taken up for a provisional order. The provisional order might subsequently be substituted for the licence, and in the meantime their rights would be protected by the rights previously obtained by the licence. If possible he would not allow any technical difficulty or any red tape to stand in the way of expediting those things if they showed how those things could be done. Then as to the question of constant supply, he thought that the obligations of the Act had been somewhat misunderstood. He did not understand that the obligation was absolute. If a constant supply was not given he understood that the undertakers would be liable to a fine; but it would be open to them to show reason why they had been unable to comply with the obligation to give a constant supply. In that case they would be released from the fine, or it would be purely nominal. He did not think that there was anything there which constituted a practical danger or a risk which would seriously interfere with their proceedings. The last point was a point upon which he agreed with them entirely in principle, although nothing had been said as to the way to give it effect. He was quite willing to give greater power to the local authority. He did not like the difficulty now cast upon him, and he would like a modified form of Home Rule, so that the local authorities would be able to deal with each case in the manner they thought right for the interests of their locality. The practical conclusion of the whole matter was this—that while he could not give any hope that he would favour the repeal of the 27th clause, he would give the best consideration to the form of clause—he should like it drawn in the form of a clause—which they might send him, for either modifying that clause in the Act or the orders to which they objected.

After some further conversation the deputation withdrew.

PARLIAMENTARY NOTICES FOR NEXT SESSION.

In the ensuing Session of Parliament the United Telephone Company notify their intention of applying for an Act authorising them, or the Company, to be incorporated by the intended Act, or their agents, licensees, or other persons "To lay down, suspend, place, erect, and maintain, and at all reasonable times to have access to, pipes, wires, posts, pillars, insulators, conductors, and other works and apparatus connected therewith, in, through, across, along, under and over, highways, streets, roads, lanes, passages, footways, and other places, tramways, railways, canals, docks, basins, waters, rivers, bridges, houses, works, and other buildings within 100 miles of the General Post Office, within the Parish of St. Martin's-le-Grand, in the City of London, and for such purposes temporarily to break up, open, or otherwise interfere with," such highways and other places and properties before enumerated, and also any sewers, drains, water or gas mains and pipes, and all other works in, over, or under such highways or other places and properties "as may be necessary or convenient for the full and efficient formation and maintenance of telephonic communication, subject to such conditions, restrictions, and regulations as may from time to time be prescribed by the Board of Trade or other public authority, or otherwise as shall be provided by the intended Act."

The Act will contain clauses to authorise the Company or the new Company to purchase and take upon lease or otherwise such lands, premises, &c., as may be necessary or expedient for offices, stations, or otherwise to enable the Company to carry out the purposes of the Act. Powers will also be asked for to authorise the Company or the new Company on the one hand, and all corporations, vestries, local and other boards and other public bodies and all railway, canal, and other companies within the limits aforesaid, on the other hand, to enter into and carry out agreements for facilitating telephonic communication. Authority will be asked enabling "the Company or the new Company, for the purposes of the intended Act, to acquire, sell, manufacture under, or otherwise use any patents and licenses for the transmission of telephonic communication, and also to grant licenses to manufacture under, or use any such patents either within or without the limits aforesaid." It is stated that "the powers and provisions of the intended Act will be either conferred upon, or be made applicable to, the Company as at present constituted, or if found necessary or desirable the Company will be dissolved and the shareholders therein re-incorporated, either with or without other persons or bodies as may be provided by the intended Act."

The Charing-cross and Waterloo Electric Railway Company will apply for leave to bring in a Bill authorising them to construct an extension of the railway to Cockspur-street—commencing at Charing-cross, about 85 yards west of the statue of King Charles I., and terminating by a junction with the commencement of the railway authorised by the Charing-cross and Waterloo Electric Railway Act, 1882. Further powers will be sought as to the compulsory purchase of lands, and as to tolls and underpinning; while an extension of time for the compulsory purchase of lands and buildings, and the construction and completion of the railway authorised by the Act of 1882, will also be asked for. By another application the company intend to ask for leave to bring in a Bill authorising the abandonment of the railway and works sanctioned by the Charing-cross and Waterloo Railway Act, 1882, and to release them from all liabilities, penalties, and obligations in respect of their completion.

The Incandescent Electric Lighting Company (Limited) will apply for leave to bring in a Bill to extend the time limited by the Birmingham Electric Lighting Order, 1883, within which the local authority may require the company to sell their undertaking for such period, and, if need be, to alter the terms and conditions of such sale in such manner as the Bill may define or Parliament may sanction, and to extend the period within which the Company are to lay down the works mentioned in the Order. Powers are asked to alter and lessen the compulsory works which the Company are by the Order required to lay down, and to define these works, or to relieve the Company from laying them down, and to make other provisions in lieu thereof; and authority is also sought to enable the Company, on the one hand, and the Corporation of Birmingham on the other hand, to enter into agreements with reference to the matters mentioned in this notice, and to confirm any contracts which have been or may be made touching any of such matters. Power is also sought to alter, extend, or repeal, so far as may be requisite or desirable for the purposes of the Bill, all or some of the provisions of the Order, and of the Electric Lighting Act, 1882; and provision is further made for the dissolution and re-incorporation of the Company.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. NOV. 19.		BUSINESS DONE WEEK ENDING NOV. 19. Highest.		Lowest.	
Anglo-American	33,	34	33¼		33	
Do. Preferred	57,	58	58¼		57	
Do. Deferred	8¼,	8¾	9¼		8¼	
Brazilian Submarine	10¾,	11¼	11¼		10¾	x.d.
Cuba	11,	11½	11		—	
Do. Preference	17,	18	—		—	
Direct Spanish	3½,	4	—		—	
Do. Preference	15,	15½	—		—	
Direct United States Cable	10½,	10⅝	10½		10⅜	
Eastern Telegraph	11⅜,	11⅝	11 9-16		11⅜	
Do. 6 per Cent. Preference	13⅝,	13¾	13¾		13⅜	
Do. 5 per Cent. Debentures, 1899	104,	107	—		—	
Eastern Extension	11⅞,	12¼	12⅛		11 15-16	
German Union	9½,	10½	—		—	
Globe Telegraph and Trust	7,	7½	7½		7⅛	
Do. Preference	12⅜,	12⅝	12⅜		12¼	
Great Northern	14,	14½	—		—	
Indo-European	32,	83	—		—	
Reuter's	7½,	8	7⅞		—	
Submarine	175,	180	176½		—	
West India and Panama	⅜,	1½	⅝		—	
Do. 1st Preference	7½,	7¾	—		—	
Western Brazilian	6¾,	7¼	7		6 13-16	
Western Union 7 per Cent. 1st Mortgage	120,	122	—		—	
Do. 6 per Cent. Sterling Bonds	100,	103	—		—	

TELEPHONES.

Consolid. Telephone and Maintenance	5-16,	7-16	⅜		—
Oriental	¼,	⅜	3-16		—
United Telephone	10¾,	11¼	11¼		10 15-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1½,	1⅝	1½		1¼
Do. (fully paid)	2½,	3½	3⅜		—
Hammond Light (£3 15s. paid)	¾,	1	1		13-16
Swan	—	—	—		—
Maxim-Weston	3-16,	5-16	—		—

MISCELLANEOUS.

Telegraph Construction	34,	35	34¼		34¼
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	22½		23

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NOTES.

TELEGRAPH CABLE INTERRUPTED.—The cable between Fao and Bushire is interrupted.

DEATH OF M. CALLAND.—M. Calland, well-known on the Continent as the inventor of a battery largely used in telegraphy, is dead.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 21st Nov. amounted to £4,781.

RAILWAY LIGHTING IN AMERICA.—We learn that a Woodhouse and Rawson electric lamp has been applied to the lighting of a car on one of the Massachusetts railways.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ended 21st Nov., 1884, were £3,789, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

RUSSIA IN THE EAST.—A St. Petersburg telegram, through Reuter's agency, dated Nov. 25, states that the Ministry of War has decided upon the immediate construction of a telegraph line from Askabad to Merv, *viâ* Anno, Babadurma, Bugatchik, Artchingan, and Sarakhs.

EARTHQUAKE IN THE UNITED STATES.—A Reuter's telegram, dated New York, Nov. 24, states that two shocks of earthquake have occurred at Concord and were also felt in other parts of New Hampshire. The second shock was more severe than the first, and shook the buildings of the city.

GENERAL TELEPHONE COMPANY.—The new general manager of the Société Générale des Téléphones, in place of M. Latigue, whose death we recorded last week, is M. Richard, an administrator (or director) of the company, formerly engineer for the Paris telegraph service, and now manager of the Bezons works.

INTENSE CURRENTS.—The President of the French Republic has appointed a commission, presided over by the Minister of Posts and Telegraphs, for drawing up a special set of regulations, fixing the technical conditions to be complied with for preventing danger to the public from electric leads for light or power.

TELEGRAPH TO ABERFOYLE.—It is probable that the North British Railway Company will soon open telegraph offices at Aberfoyle and at New Killearn Railway Station, a boon which will be greatly appreciated by the public, especially in the case of Aberfoyle, hitherto six to seven miles from the nearest telegraph office.

ELECTRICITY IN NEW YORK.—The *Standard's* N.Y. correspondent telegraphs that it has been decided to employ electric motors on the Brooklyn Bridge within sixty days, and upon the Elevated Railways within ninety days. The inventors have pooled their interests and united in the working of their patents. The result promises to be a rapid development of locomotion by the aid of electricity.

RED TAPE IN THE TELEGRAPH DEPARTMENT.—We have encountered a piece of obstruction in the telegraph administration that calls for a remedy. We had occasion to request some information by telegraph, and wished to leave a sufficient deposit to cover a long reply. But we were informed that no more than 2s. for a reply of forty words could be prepaid, and that this only applied to an ordinary telegram, not to what are known as "press telegrams" at a reduced rate.

TEMPORARY LIGHTING.—On the 18th inst., on the occasion of an "At Home," given at Surrey House by Mrs. Horniman, the reception rooms and adjoining museum were brilliantly illuminated by an installation of the electric light by means of incandescent lamps. The current for these was supplied by storage batteries, which were sent from the Electrical Power Storage Company's works at Millwall, ready charged. The lamps were of 50 volt 20 candle-power; and the method adopted ensures a perfectly steady light.

PARIS ELECTRICAL EXHIBITION, 1885.—The Société Internationale des Electriciens, desirous of contributing by all the means in its power to the development of electrical science, has decided that an exhibition shall be held in January, 1885, on the occasion of its first general assembly. The object of this exhibition is, not merely to bring into prominent notice new appliances, and to bring together the discoveries and improvements made up to date, but also to sum up the progress made, by means of lectures given by the most illustrious *savans* and the most eminent electricians.

ELECTRICITY IN SPAIN.—The Spanish Minister of Marine has entrusted the Sociedad Española de Electricidad with supplying all the electrical accessories required for the arsenals and men-of-war, especially for the electric lighting of the latter. This company has also lighted with arc lamps three war vessels, the "Victoria," the "Numancia," and the "Sagunto." The shops of the Maquinista Terrestre y Maritima Company at Barcelona are lighted by 32 arc and 20 incandescent lamps, while those of Fiol y Vives, at Centillas, have been fitted with 80 incandescent lamps.

ST. PETERSBURG TELEGRAPH CONFERENCE.—At a meeting of the Board of Directors of the Manchester Chamber of Commerce on Wednesday, a letter was read from the General Post Office, stating that the Department has no intention of proposing at the approaching International Telegraph Conference any restrictions with regard to the regulations applicable to telegraph code messages, and that no reduction in the number of letters allowed as the length of a code word was in contemplation. Indeed, the Department would oppose any such alteration if proposed by any other administration.

ELECTRIC LIGHTING OF STREETS.—The Streets Committee of the Commissioners of Sewers visited Norwich last week to see the electric lighting arrangements at Messrs. Colman's works. The lighting was pronounced to be satisfactory; and it is understood that a recommendation will be made that some of the Metropolitan streets be lighted in a similar manner. We suggest that, if the lighting is to be satisfactory, it be given to some responsible firm, and not to the "lowest or other tender." The obtaining of orders at any price has proved disastrous enough already, and if the public ask for a good light they should not object to pay for it.

CABLE IN THE ARLBERG TUNNEL.—The telegraph cable, lately laid in the Arlberg Tunnel, consists of twelve strands, of which half are reserved for the Government service and three for that of the railway, leaving three for eventualities. Each strand is formed of seven copper wires, twisted and enclosed in gutta percha, while the covering consists of tarred hemp and eighteen galvanized iron wires, twisted round which is rolled a band of tarred cotton. At each end of the cable, outside the tunnel, lightning conductors have been put up with a good earth connection, with the object of protecting the cable from any violent discharge of atmospheric electricity.

NEW POST OFFICE FOR BRADFORD.—In the new Post Office for Bradford, designed by Mr. Henry Tanner, of H.M. Board

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of Works, Leeds, and which is shortly to be commenced by Messrs. J. and W. Beanland, contractors, of that town, the public room will have more than 60ft. of counter space. The first floor of the building will be devoted exclusively to the telegraphic department. The instrument room will extend over the whole of the public hall and entrance lobbies, the telephone room being over the private letter box department; and over the inquiry, messengers', and other offices will be the superintendent's office and a room for the use of lady operators. On the second floor there will be rooms set apart for line men, mechanics, and batteries, and also for the curator.

NEW COMBINATION COMPANY.—The *Standard's* New York correspondent telegraphs that the agents of the Daft, Edison, Siemens, Brush, and Field electric motors have organised a company, with a capital of one million, half in cash, and the balance represented by patents to be distributed among the five original companies, in proportion to their relative merits, according to the judgment of Professors Sir W. Thomson and C. R. Cross, and the Presidents of the New York Central, the Pennsylvania, and the Northern Pacific Railways. These gentlemen may even award the entire half million to a single motor. The new company thus becomes the sole owner of everything at present known to be valuable in connection with electric locomotion. Its promoters are sanguine of being able to produce, within ninety days, a system that shall be applicable throughout the world.

ELECTRIC LIGHT IN GLASGOW.—The bazaar which opened in the St. Andrew's Halls on Wednesday is illuminated electrically, Prof. Jamieson, Principal of the Science and Art College, acting as hon. consulting electrician. The arrangements were carried out, under the direction of Mr. J. Law Crawford, electrician and medallist in electric lighting, by Messrs. Anderson and Munro, electrical engineers, Glasgow. There are eight Pilsen arc lamps, suspended in two groups of three each from the ceiling of the large hall, with two single arc lamps on high Venetian masts. The arc lamps are specially suitable in this case, as they are arranged so as to throw into shade the architectural features of the hall, which contrast badly with the decorations. The stalls are brightly lighted by 250 incandescent Swan and Pilsen lamps. The arc lamps are supplied with current from a Pilsen dynamo, and the incandescents from a Victoria Brush dynamo.

ELECTRIC LIGHT IN GRAVING DOCKS.—The Port of Havre, which was in 1881 fitted with the electric light, for permitting of loading and unloading vessels by day as well as by night, has now adopted this method of lighting for its graving docks. Three Gramme regulators, the height of which can be altered with decagonal reflectors, are provided for each quay, the current being led by overhead wires on ordinary telegraph posts. Two F Gramme dynamos, with a special engine, are placed in the building which contains the pumping engines for emptying the docks. Each dynamo supplies two circuits, each with three lamps, while a switch near each lamp permits of turning its current on or off. The two smaller graving docks of the Citadel Basin are lighted by four Gramme regulators similarly arranged; but as they adjoin one another, the lamps are placed so that their light may be thrown on one or the other, or on both, at pleasure. The plant was put down by Sautter and Lemonnier, of Paris.

ELECTRICITY AND CHOLERA.—In the *Daily News* of the 21st inst. there appeared an excellent article describing a visit paid by the writer to the Cholera Hospitals of Paris. At one of them he was told by Dr. Peters, the physician in charge of the cholera patients, that he had been trying both continuous currents and ice, and that though the use of the latter had been attended with the best effects, yet electricity also had done good work. It appears that electricity was tried some years back as a preventive of cholera, for in a book by the late Mr. Alfred Smee, F.R.S., entitled "Elements of Electro-Biology," and printed in 1849, the writer mentions that the alimentary canal is very easily affected by a current of electricity, and continues:—"I have heard that electricity has been advantageously employed at the Free Hospital to rally a patient in the collapsed stage of cholera—a fact which I mention here, as this disease involves to a great extent the functions of the alimentary canal."

CAUTION TO INVENTORS.—We are informed that, at the meeting of the Inventors' Institute on Monday evening last, Mr. J. S. Beeman drew attention to the question whether or not any special action should be taken by the institute to warn inventors against the risk they will run through exhibiting anything for which they have obtained provisional protection, or for which they have taken the necessary steps for so doing, at the forthcoming Inventors' Exhibition, while the Patent Office pursues its present course. He showed how under Section 7 Clause 1 of the Patent Act, 1883, anyone can take out, prior to the opening of the exhibition, a "bogus" patent by lodging a provisional which no one could understand, and which must necessarily be sent back for a clearer definition or drawings, and that the intending patentee had then about nine months' grace before he need send in his clearer definition, during which time he could be hunting all round the world for other people's brains. If this is as Mr. Beeman pointed out, surely it is deserving of immediate action.

ELECTRIC LIGHT IN SAW MILLS.—Mr. J. C. Howell, of Llanelly, under whose superintendence the electric light was applied to Messrs. Morewood and Co.'s South Wales Tin Works about two years ago, has now put down an incandescent plant at Messrs. Howell and Son's saw mills. The Swan lamps for the offices are placed in movable fittings, which are very convenient. In the laboratory is a self-regulating Crompton-Bürgin dynamo, capable of maintaining seventy-five 20-candle incandescent lamps. Accumulators supply current to the lamps when the engine is not working. The laboratory is generally lighted by six lamps, but as many as a hundred may be turned on when required for experiments. Twenty-four lamps are distributed about the mills, being, as a rule, placed over the benches, but they may be drawn down close to the work, brought underneath the benches, or moved about wherever required. Mr. Howell computes that, at Llanelly, for 1,100 hours of lighting per annum, electric light costs about the same as gas, while for 3,000 hours it is 50 per cent. cheaper.

ELECTRIC LIGHTING ACT.—We are glad to hear that immediate action is to be taken upon the suggestions of Mr. Chamberlain to the deputation reported in our last issue. It is considered very advisable that the suggestion made by the President of the Board of Trade, that the companies should submit, for the consideration of the Board of Trade, clauses embodying the desired modifications of the Act and Provisional Orders, should be acted upon without unnecessary loss of time, and a general opinion having been expressed that a committee consisting of representatives of the various electric lighting interests should be constituted to draw up such clauses and to confer with the Board of Trade. Lord Thurlow, as having introduced the deputation, has taken in hand the formation of an influential committee, which will be as representative as possible, and after having carefully considered the

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whole question will collectively submit the conclusions arrived at to the President of the Board of Trade. The Anglo-Brush Company is taking an active part in the formation of this committee, in continuation of its efforts towards the modification of the Act.

THE POST OFFICE AND THE TELEPHONE COMPANIES.—The following important communication was posted up in the Stock Exchange on Monday:—"24th November, 1884. Dear Sir: I am requested by my Board to acquaint you that the new form of licence for this company has been to-day received from the Postmaster-General. The licence is for 31 years from the 1st of January, 1881, and the following are the principal points on which concessions have been made:—The licence contains no limit of area nor restriction as to running trunk wires from town to town. Call offices may now be opened, whereby members of the public can communicate with subscribers. The claims of the Post Office to provide in the licence for the supply of telephones to the Department by the company, and the proposal that the company should pay a royalty to Government upon private wires erected and maintained by it, have been given up. By a separate agreement telephone exchanges may be connected with the Post Office, and subscribers may send and receive telegrams by telephone. I am, dear sir, yours faithfully, Thomas Blaikie, secretary. Henry Charles Burdett, Esq., Share and Loan Department, Stock Exchange, E.C."

ELECTRIC LIGHT AT TEMESVAR.—The *Standard's* Vienna correspondent telegraphed that Temesvar, in Hungary, the first European town where the electric light had totally superseded gaslight, was on Saturday and Sunday nights left in complete darkness. Since its installation at the beginning of the present month, the electric light had worked exceedingly well, and a number of foreign experts had just arrived to witness its triumph, when suddenly the whole arrangement failed. The experts believe that a severe snowstorm had disarranged the wires, but the latest telegrams say that the pumping machines working the dynamos are out of order. The real cause is that the River Bega, which supplies the pumps, was frozen over; but this difficulty is being remedied. The moral of this little *contretemps* is that all electrical plant should be duplicated, so that an accident may not cause entire failure. Especially should precautions be taken to prevent the motive power from giving out. Again, gas is not consumed directly as made, but is stored up. Just in the same way, electric current should not "live from hand to mouth," as it were, but have something to fall back upon. Our account of lighting trains on the Brighton line shows one way in which this difficulty may be avoided.

INCANDESCENT LAMPS V. BLUE DEVILS.—"I recommend light as an improver of animal spirits," said Sydney Smith. "How is it possible to be happy with two mould candles, ill snuffed? You may be virtuous, and wise, and good, but two candles will not do for animal spirits. Every night, the room in which I sit is lighted up like a town after a great naval victory, and in this cereous galaxy, and with a blazing fire, it is scarcely possible to be low-spirited; a thousand pleasing images spring up in the mind, and I can see the little blue demons scampering off like parish boys pursued by the beadle." If a "cereous galaxy" could have such an effect upon the writer, what would he have said of a galaxy of incandescent lamps. It is true that the same inspiriting effect may be had by turning on all the available gas burners in the room, but for how long? The "little blue demons" which have scampered off at the sudden blaze of light presently return, the breathing of the occupant of the room is oppressed, his head feels heavy, the eyes smart and ache, and by and by the ultramarine ones of the long tails reign supreme. His last state is worse than the first. Incandescent lamps are the only true dispersers of blue devils, and may they—the lamps, not the last mentioned—soon be within the reach of everyone.

THE LATE MR. FAWCETT.—Communications having been addressed to head-quarters, says the *Post Office Circular*, not only by individual officers, but also by offices collectively, suggesting that steps should be taken with a view to perpetuate the memory of the late Postmaster-General, the secretary is anxious to learn whether the desire thus expressed is so far general throughout the service as to justify its serious consideration. He therefore requests that heads of departments, postmasters, and others in a position to do so, will be good enough to ascertain whether there is among the officers under their control a spontaneous and general desire to join in any movement having for its object the commemoration in a suitable manner of the connection of Mr. Fawcett with the Post Office. As the value of such a movement will depend upon the spontaneousness of its character, the secretary thinks that the feeling of the Department will be best ascertained by the publication of this notice, and by its being left to the different branches of the service to take such steps as they consider desirable to represent their wishes to superior officers. All communications on the subject should be addressed to the Secretary, General Post Office, London, with the words "Fawcett Memorial" inscribed in the left-hand corner.

THE ELECTRIC LIGHTING ACT.—Commenting on the interview between Mr. Chamberlain and the representatives of the electric lighting interests, last week, the *Pall Mall Gazette* remarks:—"The electric lighting interests got some comfort from Mr. Chamberlain, and probably as much as they expected under the circumstances. With one voice they demanded the repeal of the 27th clause, which gives the local authorities powers of compulsory purchase after twenty-one years. Mr. Chamberlain as promptly replied that he could not consider such a proposal, but he invited the companies to draw up a clause embodying their views of what they thought reasonable. Mr. Forbes emphatically declared that, although there were many who were ready to stake their thousands in the enterprise, no one would do so with such a limitation as that contained in the 27th clause. If the companies are wise and diplomatic in availing themselves of Mr. Chamberlain's offer, they may now get a fair modification of the Act; but little is to be gained by an out-and-out extreme demand for the absolute freedom of action and entire freedom from all corresponding obligation made by Mr. Crompton. To grant such a request would be to relinquish at once the power to prevent the establishment of another domineering monopoly like that of the water companies. It would be a rash Government that would dare to assent to anything of the sort. But the matter may be very well arranged by giving the electric lighting companies a longer lease of life—say, thirty years instead of twenty-one."

NEW BATTERY FOR LIGHTING.—On the occasion of the Queen's leaving Balmoral, on Wednesday, the Royal dining room at Perth was lighted by Swan lamps in pink shades, supplied by current from a new battery, the joint invention of a French chemist, M. de Lelande, and Mr. Berger Spence, of Manchester and London. The battery is formed by immersing a zinc plate in a cell formed by an ordinary iron dripping pan containing a layer of oxide of copper and a solution of caustic potash or soda, and placing a number of these pans or cells in circuit, being isolated from one another by glass insulators. The battery on this occasion was formed

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by sixty of these cells placed in a retiring room, and the wires were connected with two elegant candelabra placed among the flowers on the dining room table. Each of the latter held three wax candles, through the centre of which the wires were passed, being tempered by pink coloured shades which enclosed them. Her Majesty was so charmed, on entering the room, as to give way to involuntary expressions of pleasurable surprise; and in the course of her stay she made a personal examination of the apparatus. The whole of the arrangements were superintended by Mr. C. E. Boothby, civil engineer, Springfield, Cupar, and Mr. John Home, W.S., Edinburgh. We learn that a syndicate has acquired the exclusive right to the patent for the whole of Scotland, and Mr. Home, on their behalf, is at present engaged arranging for the formation of companies in each county. A company has already been formed in Mid-Lothian with an influential board of directors.

Health and Electric Light.—Mr. Ernest Hart, in a paper on the Health Exhibition, read before the Society of Arts on Wednesday evening, observed that it was no small thing to have acquired the conviction that our open spaces may be, and should be, much more largely devoted to the open-air recreation of the people than they are at the present moment; and he continued:—"Within an arrow's flight of the houses probably of most of us who are here there lie great open spaces, such as Hyde Park (but what I say refers also to Victoria Park), which at night are dreary, desolate areas of darkness, which are unlighted, which are dangerous to cross, which are unused in the evenings for any wholesome or moral purpose, which are often scenes for the display of some of the worst vices incidental to the lowest dregs of the population of the great city. Why should we not learn from the success of the music and the lighting of the gardens of the Health Exhibition that our great parks should all be lighted by the electric light at night, and that throughout the spring and summer months the military bands should play there, and should make those places, which are now not only useless but scandals to the metropolis the sites of healthful and innocent recreation. I have inquired from a good source what would be the cost of lighting Hyde Park by the electric light; and I am not speaking without data when I say that I believe Hyde Park could be adequately lighted with the electric light, so that it might add to the resources of health and enjoyment for the teeming population surrounding it, at an annual expenditure of about £5,000."

Conversazione of the National Telephone Company.—On Wednesday night the National Telephone Company held their fourth annual *conversazione* in the Victoria Halls, West Regent-street. A large number of the *employés* and their friends assembled, and there were present, among many others, Professor W. Bottomley, Mr. F. F. Begg, Edinburgh, District Superintendents Millar of Aberdeen and Lumley of Dundee, and Mr. W. A. Smith, director, who occupied the position of chairman. In the course of the evening the chairman delivered a short address, in which he expressed the pleasure he had in being present. Referring to the progress of the company, he said that the number of people who had benefited by their labours were increased by a hundredfold, while their revenue had increased by a hundred per cent. In consequence of the liberal concessions made by the late Postmaster-General it was possible, and indeed in a short time it would be an accomplished fact, that all villages of any importance would be connected with each other by telephone. He also spoke of the useful inventions of two members of their company, namely, Messrs. Bennet and Sinclair. The former had invented an induction coil, by which they were enabled to communicate with outlying towns without running a double line of wires, and also a battery which had been successful in the hands of some. The latter was the originator of the automatic switch—one of the greatest strides that has been made in telephone work. As a matter of interest, he mentioned that the number of calls in the National Telephone system alone for the last month amounted to 684,000. During the evening dancing was carried on with zeal, and was occasionally varied by intervals of songs and music.

Compound Dynamos.—In an article on the use of compound dynamos for maintaining incandescent lamps, the *Zeitschrift für Elektrotechnik* contends that the differences of potential at the terminals does not remain constant, so as to dispense with a regulator. Our contemporary continues as follows:—"In fact, an installation of incandescent lamps cannot be regarded as satisfactory unless they last for 800 or 1,000 hours; but, to obtain this result each lamp must not be subject to variations greater than 1 per cent. of its normal potential. Now such a constancy cannot be ensured without a regulator, even with the compounds, for if the intensity of the current vary 20 per cent. the difference at the poles will vary about 3 per cent. A good shunt dynamo (an Edison for instance) gives almost as satisfactory results, since the intensity, increasing by 10 per cent. the difference of potential at the terminals only increases by 1 per cent. and 4 per cent. for an increased intensity of 25 per cent. But there are causes of irregularity still more unfavourable to the constancy of the difference of potential at the terminals, than are the variations in speed of the engine, which more often than not attains as much as 5 per cent., causing similar discrepancies in the difference of potential at the terminals; and no plant is so carefully put down from a mechanical point of view that the driver can answer for a constancy in the number of revolutions of his engine without a governor. The losses of pressure in the conductors are a third source of variation in the difference of potential. A plant may, in fact, be considered to be put down under good conditions for which a loss on this head of only 10 per cent. is reckoned; that is to say, 8 per cent. for the principal conductors and 2 per cent. for the shunt circuits maintaining the lamps. If, then, a group of lamps be switched off, and the intensity be reduced by one-half, the resistance of the main conductor is just so much reduced; and the lamps which remain in incandescence work under a tension 4 per cent. greater. Lastly, there is a fourth cause of inconstancy, which is the heating of the dynamos. For if, some time after starting, the resistance of the machine be modified in consequence of the heating of the conductors, there also follows a modification in the difference of potential to which the combinations of the best designed compounds can offer no remedy. In fact, in all installations with compounds, it is always found necessary to add a regulator sooner or later. But in that case, if a regulator be required, as with a simple dynamo, of what advantage is the compound? Is the useful effect greater? No! for at recent exhibitions it was the shunt-dynamos which gave the best results. Are sparks more easily avoided? That is not proved. On the other hand, compounds have an incontestable disadvantage, which is that, in short circuit, the conductor of the induced current often burns notwithstanding the best cut-outs, while with the shunt-dynamos there is only a lessening of intensity."

Edison's Lighting Station in New York.—We have from time to time given particulars of the central station established by Edison in New York, and opened in September, 1882. But we find in the *Statist* a comprehensive account,

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from which the following abstract is made:—The space lighted is contained in a square of 2,400ft., and has, therefore, an area of something less than a quarter of a square mile. The district contains about 50 blocks of buildings, and is intersected by some 15 streets or passages. The necessary permission to open the streets to lay the electric mains was obtained, not by Act of Congress or by other legislative or official means, but by the simpler and perhaps less costly method of a payment of about £10,000 to Tammany, and in exchange for this payment the Edison Company is free to take up the streets when necessary for electric lighting purposes. On 4th September, 1882, the station was started with 2,323 lamps, contained in about 85 houses, and these increased in number until 12,540 lamps were installed, the present capacity of the station being now attained. The largest number of lamps ever burning at one time was 5,530, in January of this year, and their average life, based on about 12,000 renewals, is a little more than 400 hours. Shortly after the installation of the station it was found that some of the customers did not require the light in the summer, and that consequently their custom involved loss. It became necessary, therefore, to cull from among the customers those whose demand was less than an average of $2\frac{3}{4}$ hours per day for every lamp connected on their premises. If their consumption fell short of this standard, they were quietly got rid of, so that the actual average consumption of the light per lamp was artificially raised above the normal gas average of the district. The cost of gas in the First District of New York is about 9s. 2d. per 1,000 cubic feet. Competition, therefore, with the elder illuminant, having regard to the the power of picking the good customers, and of unreserved access to the streets, was rendered distinctly favourable. Added to this was the fact of Mr. Edison's presence, and the supply of ample funds; still, the financial result is disappointing. The management of the station has been—at any rate during the period over which the returns extend—able, economical, and efficient. Not only is American genius more suited to the exploitation of new industrial developments than that of older countries, but there is a general disposition to help along a new scientific undertaking. The cost of the station is somewhat in excess of £200,000, and the annual expenditure is at the rate of nearly £16,000 a year—without including depreciation, sinking fund, or interest on capital. The excess of receipts over actual cash outlay amounts to about £6,000 a year, or 3 per cent. on the capital invested. In order to appreciate the precise nature of the result of this experiment, it is necessary to suppose that each lamp is replaced by a 5-foot gas burner, and that the amount of gas consumed to produce an equivalent of light be computed. The result of this calculation gives 6s. 11d. as the cost per 1,000 cubic feet of the gas thus consumed. If, however, a 16-candle lamp be held to compete with a 7-foot gas jet, then the equivalent is as nearly as may be 5s. per 1,000 cubic feet. To compete with gas at 3s., the cost of maintenance—*i.e.*, of production—must be reduced by two-thirds.

TERRESTRIAL MAGNETISM.—M. J. B. Baille contributes to *L'Electricien* the following note on measuring the horizontal component of terrestrial magnetism by the dead beat (*amortissement*) method:—The horizontal component T of terrestrial magnetism is generally determined in absolute value by the method of Gauss, which gives at the same time the magnetic moment M of the bar magnet. But the application of this method has several disadvantages. It is necessary to employ two magnets and make two observations independent of each other, separated by a sufficiently long interval of time, during which the terrestrial force may vary. I propose to apply to this investigation the old observation of Gambey and of Arago on the prompt dead beat of magnets oscillating above a thick copper plate. It is well known that a magnetised bar, oscillating inside a coil, is more or less dead-beat according as the coil constitutes an open or closed circuit. On measuring the dead beat in both cases, the moment h of the reaction which the induced currents exert on the movable magnet is obtained by difference. This element is connected with the magnetic moment of the oscillating bar M, and with the electric constants of the coil, a resistance expressed in W ohms, and G galvanic constant in centimetres, by the well-known formula $M^2 = W G^2/h$. If then h be measured, and if the value of the constants WG^2 be known at the moment of making the observation, M may be calculated. Now, as the directing couple T M has been already determined by means of the duration of an oscillation and knowledge of the moment of inertia, the number T may be obtained by a division, into absolute value, into units C.-G.-S, for instance, if all the other elements have been measured with the corresponding units. This method is very simple and very rapid; it requires the use of only a single magnet, which may be always the same, and it lasts scarcely a few minutes. Moreover, it appears, perhaps, still more precise than Gauss's method, since it gives the horizontal component at the precise moment of the observation. Besides, the dead beat of an oscillating motion is one of the physical elements which it is easiest to determine with accuracy, when suitable precautions are taken to secure good oscillations; and the observation of it may be made at the same time as that of the duration of the oscillations. There are, however, two difficulties which may greatly disturb the measurements, if care be not taken to allow for them. In the first place, the effect of the self-induction is to change the induced currents. It is therefore necessary to make a suitable correction at each observation; but it is simpler to eliminate this cause of error, which may be done by taking a coil having a small number of turns of wire, and especially by attaching to the magnet a piece having a strong moment of inertia, so that the duration of an oscillation be sufficiently long. Next, the variation of the declension has the effect of rendering the dead beat unsymmetrical, and presents itself like an irregularity of the oscillations. This source of error may be neglected if care be taken to make the observations quickly, and to take into consideration an even number of amplitudes. The declension may in that case be regarded as having varied regularly. The constants of the coil to be previously determined are the electrical resistance W, which will be increased by ordinary methods, and which will be reduced, by means of a suitable correction, to the temperature of the observation, and then the galvanometric constant G. This last element is sufficiently difficult to obtain by ordinary methods; but it might have been concluded from the first dead beat observations, if care was taken to put in the coil a bar the magnetic moment of which was determined beforehand by Gauss's method. I have applied the dead-beat method, as now described, with a coil, the electric elements of which were measured separately. I have determined the horizontal terrestrial component in my magnetic observation at Villeneuve-Saint-Georges. From numerous results which I have obtained, and which agree well with one another, I extract the following observations, in which the two methods were employed concurrently (C.-G.-S. units):—On 25th September: Magnet A, Gauss method, 0·1943; dead beat method, 0·1938; Magnet B, Gauss, 0·19413; dead beat, 0·19532. 26th September: Magnet M, Gauss, 0·19487; dead beat, 0·19512; Magnet N, Gauss, 0·1945; dead beat, 0·19464. As may be seen, the results are as concordant as possible, and the method I describe is worthy of all confidence.

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THE STEAM ENGINE INDICATOR.—III.

BY AMICE.

Towards the conclusion of the article in our last impression we gave the reasons which made it necessary to employ, in an indicator for taking diagrams from modern engines, a spring of short range and a piston as light as possible, and light attached parts. These requirements were, as far as seemed necessary at the time, embodied in Richards's indicator, of which we now give an engraving (Fig. 7), showing the indicator as originally made. This gives but an external view, which is sufficient for our present purpose. It will be seen that the piston rod is attached by a short link to an arm forming part of a small parallel motion. This attachment is made at one-fourth of the length of the arm from its fulcrum on the indicator frame. The end of this arm has, therefore, a range of movement four times that of the indicator piston,

The Richards Indicator, 1868.

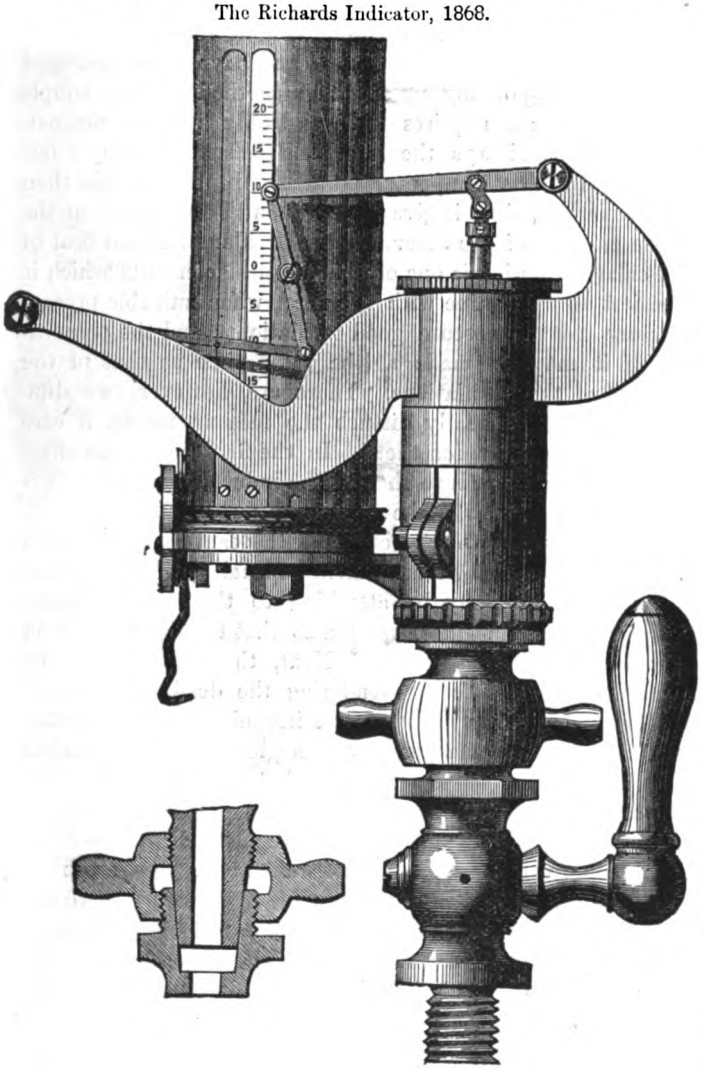

Fig. 8 Fig. 7.

and, consequently, the pencil which is carried at the centre of the middle member of the parallel motion has the same range. The indicator card, or paper on which the indication is taken, is placed upon the drum seen behind the pencil, and held by the light spring clip, one part of which is shown graduated. The strong curved arm carrying the parallel motion is free to turn upon the outer part of the indicator cylinder, and thus the pencil may be withdrawn from or put into contact with the drum on which the paper is wound. By means of the cord seen below the paper drum, and in the grooved sheave at the bottom of the drum the latter is attached to some part of the engine, so as to receive motion synchronous with the steam engine piston. The return motion of the drum is effected by a coiled spring within the drum. The string is thus always kept tight under the tension due to the spring in the drum. As the velocity of recoil of a steel spring is about 1,300 feet per second, no engine piston moves fast enough to cause the slack in the string which produced the jerky motion in the return stroke as effected by a weight in the Watt indicator. The small engraving (Fig. 8) is a section of the upper part of the cock which is screwed into the steam-engine cylinder or a pipe attached thereto, and of the lower part of the indicator cylinder with the fly-nut by which the indicator is attached to the cock. Two of these cocks may be employed, one fixed on either end of the engine cylinder. To take a diagram from either end of the cylinder it is, then, only necessary to remove the indicator from either fixed cock by unscrewing the fly-nut, the taper end of the indicator cylinder being steam-tight in the upper part of either cock. Instead of this it is common when a number of diagrams have to be taken to connect the two ends of the cylinder by a pipe with one three-way cock in the centre, to which the indicator points; it is then only necessary to turn the cock one way or the other to take a diagram from either end.

This indicator was a very great improvement on the best that had preceded it, and is at the present time very largely in use with but minor improvements. These improvements are, however, of considerable value, and as it is not necessary to show them separately, we may show them by reference to the recent form of Richards indicator shown in Fig. 8A and to a modification of the Richards indicator by Mr. Richardson, by means of which a continuous series of indications may be taken on a long strip of paper. This indicator is an improvement upon one made by MM. Guinotte and De Hennault, also introduced by Messrs. Elliott Brothers, and shown by Fig. 9, and Fig. 10 is illustrative on a small scale of a series of diagrams taken from an engine with Corliss's valve gear. One of the improvements consists in the use of the fly-nut below the paper drum by which the part carrying the little pulleys which guide the string can be without loss of time adjusted to any position which may be necessary to place them in a line with the string when attached to the moving part of a steam engine. A second improvement consists in the use of a device for instantaneously stopping or starting the paper drum without disconnecting the string by which the motion is communicated to the drum. With slow running engines the latter is not at all difficult, but with high speeds it is not only sometimes difficult to disconnect or connect the string to the indicator while the engine is running, but is sometimes dangerous. The device by which this is overcome is known as Darke's patent detent. It is simple, and consists of a ratchet segment on the bottom of the paper drum, and a small pawl controlled by a light spring attached to the outside of the cylinder. The pawl is seen in Fig. 9, upon a short pedestal between the drum and cylinder. As shown, it is out of gear, but if the string were pulled and the drum turned as in work, so as to bring the ratchet teeth round about three-fourths of a revolution from the position shown, the pawl would, by moving the little knob on the spring in front of the cylinder, go into gear, and the drum would be held by it against the resistance of the drum spring. The string would then hang slack during the return stroke of the reciprocating part of the engine by which the string is moved. These two engravings show the distinguishing features of the Richards indicator as far as external parts are concerned; but, as already observed, it was not only the use of the parallel motion which formed a feature, but the use of a short spring, with light internal piston. To these springs we shall refer further on. For the present, having the continuous indicator before us, we may briefly describe it. It is in form a Richards indicator, but is somewhat larger, more especially in the drum. In the interior of the latter is a receptacle for a roll of paper, the end of which is brought through a slot. It is then passed round the cylinder, and is inserted again into the interior, when it is caught by a slotted roller, which roller is worked in one direction during the motion of the paper drum. The backward and forward rotation of the drum gives intermittent motion to a train of small gearing, part of which is seen in the upper part of the drum. By means of the notched disc at the top of the drum, and the little spring catch lever which takes into the notches, diagrams may either be taken continuously, or if necessary single diagrams

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may be taken in the same way as an ordinary Richards indicator, or by throwing the drum out of gear by the Darke's detent they may be taken occasionally. When the notched disc is set fast by the spring catch shown in one of the notches, the small train of gearing by which the roll of paper is actuated is in gear, but when the catch is not in the notch the whole of the drum and its contents work just as an ordinary Richards indicator, and single diagrams can be taken in the ordinary way. When the diagrams have all been taken, the length of paper can readily be pulled off the roller. The paper is supplied in rolls, and the trouble of coiling it on the cylinder is entirely avoided. About 150 diagrams can be taken on each roll of paper.

Modern practice has continually increased not only the speed of engines, but the pressure at which they work, and the necessity has arisen for an indicator which has moving parts for carrying the pencil even lighter than those in that of Richards. The reasons which made Richards' invention necessary have again made it necessary to improve the apparatus. Not only do the high speeds and pressures tend to break the parallel motion, but the several parts spring a little, and this with slight looseness in the joints, together with the inertia of the whole, conspire to increase the unsteadiness of the pressure line, giving to it a fluctuating waving form which is not a faithful representation of the real pressure in the cylinder. The total error, however, has probably been exaggerated, except with respect to what are now known as high speed engines, but a modification has become sufficiently imperative to induce Messrs. Elliot Brothers, of Charing-cross, who have been the sole makers of the Richards indicator, to bring out the form of indicator known as Darke's patent; and even the Richards indicators now made by them are fitted with Darke's pencil motion instead of the parallel motion, unless otherwise ordered. We will therefore, before entering upon the use of the steam engine indicator, describe this latest development of the instrument by these well-known makers; but inasmuch as an indicator, known as Kraft's, and having a pencil arm with a free end and other points of interest, appeared before Darke's, we must first describe and illustrate this.

The Richards Indicator, 1882.

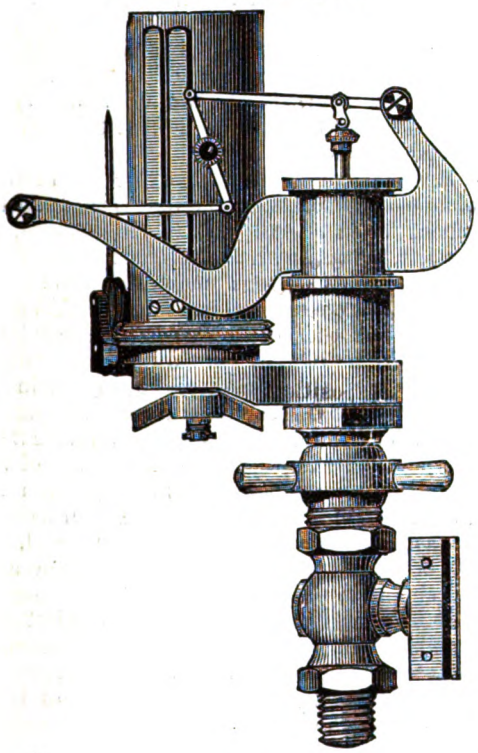

Fig. 8A.

Continuous Indicator.

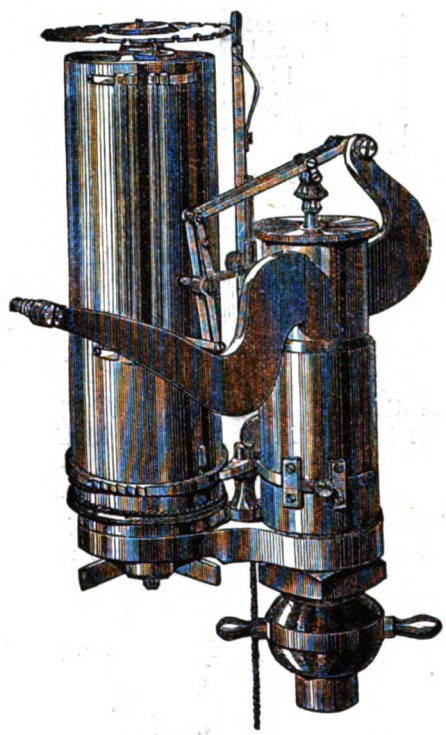

Fig. 9.

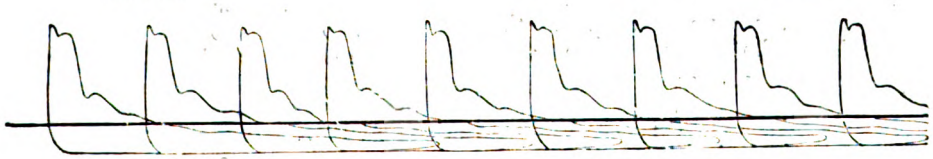

Fig. 10.—Diagrams from Continuous Indicator.

THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 29.)

m_1 Coils in Sequence with m_2 Coils in Parallel.

It may be inferred from the preceding that, if we join up equal coils in any manner to form a linear system of conductors the determinantal equation of the system will be merely $x^a y^b = 0$, a and b being integers. This will be evident from the section to follow on unequal coils, so at present we take it for granted, to avoid unnecessary repetition. The general case of a linear system, with equal coils, will be considerably lightened by first taking a simple case combining coils in sequence, and coils in parallel, say two coils in sequence with three in parallel, as in the figure (which I dare say the printers will be able to make up, as it consists wholly of straight lines and numerals. *See* page 48).

The numerals showing the position of the coils, and the lines their connections, given at a certain moment there to be distributions of magnetic force H_1, H_2, &c., in the five cores, and that there are no external impressed forces, the manner of subsidence is required, knowing that it is the resultant of the two manners corresponding to $x = 0$ and $y = 0$.

Let there be, in the first place, a distribution of magnetic force H_1 in the first core only, the rest being uncharged. Whatever current is set up in the 1st coil, we must, by continuity, have the same current in the 2nd, and by continuity

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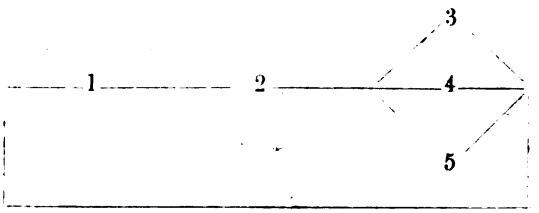
and symmetry one-third of this current in the 3rd, 4th, and 5th coils, all similarly directed, say from left to right. The proportions are 1, 1, $\frac{1}{3}$, $\frac{1}{3}$, $\frac{1}{3}$, and these must be the relative magnitudes of the magnetic forces at the boundaries of the five cores, after the subsidence has commenced. Also, at the first moment, we have to cancel the magnetic force in the 2nd, 3rd, 4th, and 5th cores. Thus we must have another set, z, -1, $-\frac{1}{3}$, $-\frac{1}{3}$, $-\frac{1}{3}$, where z, for the 1st coil, is yet unsettled. To find it, by the



(Figure referred to in previous column.)

principle that this set must set up no current in the coils, the common $-\frac{1}{3}$ in the 3rd, 4th, and 5th branches must be balanced by $+\frac{1}{3}$ in the branch formed by the 1st and 2nd taken together. This gives $z=\frac{4}{3}$, and $1+z=\frac{7}{3}$, the complete boundary force in the 1st core on the same scale. So, multiplying by $\frac{3}{7}H_1$ throughout, we find

$$h_1=\tfrac{4}{7}H_1,\quad h_2=-\tfrac{3}{7}H_1,\quad h_3=h_4=h_5=-\tfrac{1}{7}H_1,\quad .\quad (120)$$

as the five distributions which subside in the first manner, without current in coils. A similar set of distributions corresponds to H_2, since the second coil is in sequence with the first, giving

$$h_1=-\tfrac{3}{7}H_2,\quad h_2=\tfrac{4}{7}H_2,\quad h_3=h_4=h_5=-\tfrac{1}{7}H_2,\quad .\quad .\quad (121)$$

to subside in the first manner.

With H_3 the distributions are different. The current of strength 1 in the 3rd coil, due to E.M.F. in itself only, divides thus

$$\tfrac{1}{5},\quad \tfrac{1}{5},\quad 1,\quad -\tfrac{2}{5},\quad -\tfrac{2}{5},$$

in the five coils, and these are the proportions of the boundary magnetic forces. To cancel them at the first moment in all cores except the 3rd, we require the supplementary set

$$-\tfrac{1}{5},\quad -\tfrac{1}{5},\quad z,\quad \tfrac{2}{5},\quad \tfrac{2}{5};$$

where z must evidently be $\frac{2}{5}$. This gives us, multiplying by $\frac{5}{7}H_3$,

$$h_1=h_2=-\tfrac{1}{7}H_3,\quad h_3=h_4=h_5=\tfrac{2}{7}H_3,\quad .\quad .\quad .\quad (122)$$

to subside in the first manner. The corresponding distributions for H_4 and H_5 are got by writing first H_4 and then H_5 for H_3 in (122). Putting together (120), (121), (122), and the two equations similar to the last, we find h_1, h_2, ..., the complete distributions to subside in the first manner, to be

$$\left.\begin{aligned} h_1&=\tfrac{4}{7}H_1-\tfrac{3}{7}H_2\quad -\tfrac{1}{7}(H_3+H_4+H_5),\\ h_2&=-\tfrac{3}{7}H_1+\tfrac{4}{7}H_2-\tfrac{1}{7}(.\ .\ .\ .\ .),\\ h_3=h_4=h_5&=-\tfrac{1}{7}(H_1+H_2)+\tfrac{2}{7}(.\ .\ .\ .\ .),\end{aligned}\right\}\quad .\quad .\quad (123)$$

The complementary distributions H_1-h_1, H_2-h_2, &c., are to subside in the second manner, as if the coils were short circuited.

In all the preceding relating to coils in sequence and in parallel, we have, for facility of description, referred to the H's as the initial distributions in the *cores*. But should the coils be not of very small depth, we must, along with the core distribution H, consider the coil distribution of magnetic force; and, again, if there be external self-induction associated with the coil, there is a certain unknown distribution, though known amount, of magnetic induction, depending on the strength of the coil current. These supplements to the H's have to be treated in the same manner as the H's, and may be imagined to be included in them.

Any Combination of Equal Coils, with Cores.

It may have been observed by the attentive reader (I hope I have at least one), especially in a study of the contents of the last section relating to five coils, that there is a general principle underlying the method of finding the two sets of distributions, a knowledge of which is essential in finding how the subsidence takes place. The principle, like most principles, shows itself more prominently by putting on one side all the insignificant details of special solutions (although the study of special solutions is, if not indispensable, at least very desirable), and viewing the matter more generally. First, to define what is meant by "any combination . . ." in the title of this section. It is any combination as hereinafter set forth and described. The unit, which is the element of the combination, is a coil with a core, joined in sequence with an external conductor. Any number of such units, all alike as regards main coils, cores, and external conductors, may be connected in sequence to form a branch; and, finally, any number of branches, containing different numbers of units, may be joined together to form a network, a linear system of conductors, so far as the wire of the coils and external conductors is concerned.

Given at any moment the state of magnetic force (subject to the previous restrictions as to direction and symmetry) in all the cores, with, if necessary, the strength of current in each coil at the same time, what happens when the system is left to itself without impressed E.M.F., that is, left under the influence of the E.M.F.'s of induction only? We may, for instance, imagine the separate units, previously separately charged, to be instantaneously connected together to form the aforesaid combination.

The complete solution may be expressed in terms of the already-obtained two solutions. The one is that which expresses what happens when a unit, as above specified, previously charged, is left to itself with the coil circuit interrupted; the other expresses what happens under the same circumstances except that the coil circuit is closed. In the first case we have induced currents in the core only; in the second case in the coil also, and with a different and slower manner of subsidence of the core's magnetisation, if there be any, or in general, of the magnetic induction. The determinantal equation of the combination is of the form $x^a y^b=0$, and we have $x=0$ for the first manner and $y=0$ for the second manner of subsidence. We only require to decompose the initially given states into two sets, such that in one of them we shall have $x=0$, and subsidence as if all the wires were disconnected, and in the other $y=0$, or subsidence as if every unit formed an independent closed circuit.

This may be done generally, as done in the last section with a simple combination, by making use of the following property connecting steady impressed forces and currents in a linear system of conductors. Let the resistances of the different branches be R_1, R_2, ...; the impressed forces acting in them $E_1, E_2, \ldots$, and let the currents be $C_1, C_2, \ldots$. These currents are what result from the simultaneous action of all the impressed forces. They may be found by the application of Ohm's law to every conductor; either symmetrically, or, when the system is not very complex, by the easier ways that present themselves.

Now remove the impressed forces $E_1, E_2 \ldots$, and substitute others $F_1, F_2, \ldots$, of such strengths that

$$F_1=E_1-R_1C_1,\qquad F_2=E_2-R_2C_2,\ \&c.$$

There will now be no current in any of the conductors.

This may be very easily seen. For, if in the original distribution of current, the rises of potential in the directions of the currents C_1, &c., in the conductors of resistances R_1, &c., be ΔP_1, ΔP_2, &c., the complete E.M.F.'s in the branches are $E_1-\Delta P_1$, $E_2-\Delta P_2$, &c. Hence, by Ohm's law,

$$E_1-\Delta P_1=R_1C_1,\qquad E_2-\Delta P_2=R_2C_2,\ \&c.$$

Thus, our defined second set of impressed forces to take the place of E_1, &c., are given by

$$F_1=\Delta P_1,\qquad F_2=\Delta P_2,\ \&c.$$

and consequently, by the elementary potential property, there is no resultant impressed force in any of the closed circuits that can be made up in the linear system, and therefore no current in any of the branches.

[In three dimensional steady flow, ρ being the specific resistance, E the impressed force per unit length, γ the current

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density, and P the potential, we have

$$E - \nabla P = \rho\gamma$$

in the first distribution; and the second distribution of impressed force is $F = \nabla P$, producing no current.]

Thus, with an impressed force in one conductor only to start with, there is a definite distribution of impressed force in the whole system that gives no current; so, if there are m branches, there are m different systems of balancing impressed forces, and the perfectly general system is to be got by taking these m systems simultaneously, in any separate proportions of strength.

We have now only to apply this property to our combination. Let an impressed force of unit strength act steadily in one of the coils, say the first, and find the distribution of current set up. Let it be e_1/r, e_2/r, e_3/r, &c., where r is the common resistance of every unit in the combination. Thus e_1, e_2, e_3, ... are a set of proper fractions, and the set of impressed forces of strengths $1 - e_1$, $-e_2$, $-e_3$, &c., in the first, second, &c., coils would, by the preceding, set up no current in the coils. Let H_1 be the initial magnetic force in the first core, a function of the distance from the axis, and let the other cores be uncharged. The distributions e_1H_1, e_2H_1, e_3H_1, &c., if they existed alone would subside in the second manner, as if every unit in the combination formed a separate closed circuit. The supplementary distributions $(1 - e_1)H_1$, $-e_2H_1$, $-e_3H_1$, &c., if they existed alone, would subside in the first manner, without current in the coils. Superimpose these two distributions, and we have the actual initial distribution, and at any subsequent moment the state of the system will be the resultant of what these distributions would have then become. Similarly we may treat the initial magnetic forces in the other cores. If the second coil be in sequence with the first the same set of ratios e_1, e_2, e_3, ..., is to be used. But in passing to another branch in the combinations, we must, in general, find another set of ratios. Having gone over the whole combination in this way, it is a question of simple addition or subtraction to obtain the final resultant solutions.

(TO BE CONTINUED.)

ELECTRIC LIGHT ON THE BRIGHTON LINE.

On Tuesday evening last, the Board of Trade inspectors made themselves acquainted with the working of the system of electric lighting applied by the London, Brighton, and South Coast Railway Company to a local train, which works their suburban traffic between Victoria, the Crystal Palace, and London Bridge. This, the first train which has been fitted with a self-supplying source of current for electric lighting, consists of eleven carriages, which are lighted by thirty-two 16-candle incandescent lamps. The train began running on 19th December, 1883, and has, with slight exceptions, been working ever since, having made 2,352 trips and run about 27,322 miles.

The system of lighting is the joint invention of Mr. Stroudley, the locomotive superintendent, and Mr. Houghton, the telegraph engineer, who began their experiments in this direction two and half years ago. It was first tried by M. Philippart, then by Messrs. Ayrton and Perry, and then handed over to the Railway Electrical Contractors (Limited), by whose manager, Mr. T. M. Collet, it has been brought into practical operation. In the installation on the Brighton line a No. 5 shunt-wound Brush dynamo of 45 volts (placed in the guard's van), giving about 38 amperes, is driven constantly by a link belt off a pulley on an intermediate shaft, which receives its motion by similar means from one of the axles. When the speed exceeds 20 miles an hour, an ingenious controlling apparatus, somewhat resembling the ordinary speed indicator, makes contact, and thus brings two pairs of brushes on to the commutator. This controlling apparatus consists of a small hollow cylinder filled with mercury, placed in a horizontal position, and having two vertical tubes in communication, one with each end. In the cylinder works an Archimedean screw, driven by a strap from the dynamo spindle. As the speed of the train, of the dynamo, and consequently of the screw increases, the mercury rises in one or other tube, according to the direction of the train; and when it reaches the metallic contact, which may be set by a screw to correspond with any speed, one or other set of brushes is brought on to the commutator. By this arrangement the dynamo is only connected with the accumulators when its E.M.F. is higher than that in the batteries.

The electrical energy is stored up in twenty-two Faure-Sellon-Volckmar accumulators, weighing about 1cwt. each, while the dynamo weighs 8cwt., thus making altogether only an additional weight of one ton and a half. When, however, the lamp circuit is switched on, the current goes direct to the lamps, by the law that electricity chooses the path of least resistance, only the excess of current, if any, then going into the accumulators. Thus the dynamo generates, during the day, a reserve of energy for use at night; and therefore it is not necessary to employ a dynamo of the full power required for maintaining the lamps. Besides being on during the night, the lamps are turned on by the guard, by means of a switch in his van, while passing through tunnels; and here be it remarked that no electrician is required to accompany the train, while the additional power absorbed by the dynamo is amply supplied by a few hundredweight of coal extra on a 50 mile journey. The wires are coupled up between the carriages by the simple connection of a pin entering a socket, which permits of this connection being broken automatically on uncoupling the carriages. It was feared that the jarring of the train would exert an injurious influence on the storage batteries; but such has not been the case; on the contrary, it has been found beneficial by preventing the formation of any deposit on the plates. The dynamo and batteries are so calculated that, even if the train ran at the rate of 60 miles an hour, too much current would not be generated for the batteries; but, in such a case, a controlling apparatus would prevent the storage battery from working back upon the dynamo.

The application of this system of lighting to a local, stopping train, places it at great disadvantage, and fully tests its value. A similar plant is also fitted to two expresses between London and Brighton. The local train started soon after 7 p.m. on Tuesday, and ran to the Crystal Palace and back, taking up passengers at every station in the ordinary way. We were unfortunate in getting into a compartment where the light, though steady when stopping, was by no means uniform while running; but as, on comparing notes with other visitors, we found this was by no means the case generally, we are disposed to attribute the variation to insufficient contact in the lamp-holder. Besides the three inspectors of the Board of Trade—Colonel Rich, Colonel Yolland, and Major Armstrong, R.E.—there were present:—Mr. John Pender, M.P., chairman of the Eastern Telegraph Company; the Hon. Thos. Freemantle and Mr. Lopes, directors of the Brighton Company; Mr. J. P. Knight, the general manager; and Mr. Richardson, superintendent of the line; Sir Daniel Cooper, Bart.; Sir Henry Tyler, M.P.; Mr. Latimer Clark; Mr. Verrinder, superintendent of the South-Western Railway; Mr. Spagnoletti, telegraph engineer on the Great Western Railway; and other gentlemen scientifically interested in the progress of electric lighting.

FATAL ACCIDENT FROM ELECTRIC CURRENT.

On Tuesday last a fatal accident happened to a man named Moore, at the Eston Steel Works of Messrs. Bolckow, Vaughan, and Co. (Limited), near Middlesbrough. It is reported that, while an examination of the engine was being made, the electric light began to flicker. An engine driver named Moore picked up a piece of stick, and put the end of it against the lamp, with the intention of adjusting the carbons. For an instant the light went out; and Moore, thinking perhaps that the electric current had been switched off, caught hold of the apparatus in the lamp. He had hardly touched the lamp when the current returned in full force, and sent such a severe shock through his body that he instantly fell back dead.

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THE ELECTRICIAN.

VOLUME XIII.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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ANSWER TO CORRESPONDENT.

J. R. COVENEY.—*The Edison-Swan United, 57, Holborn; The Anglo-American Brush Company, Belvedere-road; The Hammond Company, Appold-street, Finsbury; Crompton and Co., 4, Mansion House-buildings, E.C.; F. G. Howard, 36, Cleveland-street, Fitzroy-square; Johnson and Phillips, 14, Union-court, Old Broad-street, E.C.; Woodhouse and Rawson, 11, Queen Victoria-street, E.C.; Maxim-Weston, 32, Queen Victoria-street; Paterson and Cooper, Pownall-road, Dalston; Oppermann Bros., 172, St. John-street, Clerkenwell.*

DR. EDWARD DAVY.

It was with some natural feeling of pride we were able to announce in our last issue that the distinction of Honorary Member of the Society of Telegraph Engineers and of Electricians had been conferred upon Mr. Edward Davy, and that by the appreciative courtesy of the Eastern and Eastern Extension Telegraph Companies the fact had been communicated to him by telegraph and his acknowledgments duly received. To Mr. Fahie's industry we owe the discovery which Mr. Davy's modesty had allowed to be well nigh forgotten; and to Mr. Fahie's chivalrous advocacy, chiefly through the columns of this journal, Mr. Davy owes the tardy but well deserved recognition of his merits as an inventor of electric telegraphy. It must have been peculiarly gratifying to Mr. Davy that the news of his preferment, so to speak, to the rank of peer among practical electricians should reach him by the very medium which he had predicted forty-six years ago would one day be able to annihilate distance both by land and sea—a prediction which he himself had a large, though till now unacknowledged, share in fulfilling. In the year 1838 Mr. Davy was so confident of the future of the experimental telegraph on which he was then engaged that he could not avoid "looking at the system of electrical communication between distant places as a system which will one of these days become an especial element in social intercourse. As railways are already doing, it will tend still further to bring remote places in effect nearer together. If the one may be said to diminish distance the other may be said to annihilate it altogether, being instantaneous." He also foreshadowed a system of insulated conductor or "cable" for submarine communication; and even expressed his conviction that the Government would, or rather ought to, take this newly discovered means of instantaneous communication into its own hands "as a branch of the Post Office." In the letter which contains this remarkable piece of advice Mr. Davy adds, with perhaps some inward misgivings, that he can "scarcely imagine that there would be such absurd illiberality as to appropriate it (the invention) without compensation." Imagination almost fails us when we try to picture the money compensation that might have been earned and saved by the "Government" had it acted on Mr. Davy's suggestion.

It is not as a prophet, however, that the obscure chemist of 1838 is entitled to honour in his own country. Inventors are not unusually prophetic; they see what they wish to see, and what lookers-on cannot fathom, simply because their eyes are not sharpened by self-interest or brightened by the expectation of fame. It is a commonplace joke to ridicule the blindness of great men's contemporaries; but greatness is a relative term, and a title to exceptional renown is earned by greatness exceeding that of one's neighbours. Mr. Davy, as was quite natural in the circumstances, saw a vast deal further into the future of electric telegraph than other people; but to say that they were stupid or obstinate in not seeing exactly what he saw would be to deprive him of the special distinction which is his due. That distinction is a small matter, however, compared with the practical work he actually achieved. For a correct estimate of the world's indebtedness in this respect to Dr. Davy our readers may refer to last year's *Electrician* (Vol. XI., Nos. 8, 9, 10, and 11), where the result of Mr. Fahie's investigations into Davy's connection with the earliest history of practical telegraphy is fully set forth. The account would be a remarkable one in any case; but coming as it did so many years after the events to which they related the disclosures were simply astounding. They showed beyond all possible cavil that we had credited the invention of the telegraph to the wrong persons, or at all events had not credited it to one person whose claim was as strong or stronger than theirs. Some years prior to the patent of Cooke and Wheatstone, Davy had experimented successfully with the system devised by him, and had matured it before they obtained security at the Patent Office for theirs. His system was wonderfully complete, more so than the one which thrust it aside, and in several respects it forestalled inventions and appliances of a still later period. The curious may inquire into the subject as a phase in the ethics of patents. All we are concerned with, however, is to state the facts, and to congratulate the world in being fortunate enough to do an act of justice, and Mr. Davy in having justice done to him in his own lifetime.

Mr. Davy's honours were snatched from him at a moment when their fitting reward would have been most opportune. In the interests of that social and commercial intercourse

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which the telegraph was so greatly to advance it was perhaps fortunate that its promotion fell into hands more energetic, more self-asserting, and more business-like than Mr. Davy could pretend to. That he left England without any public assertion of his claims, that he has remained in Australia, become one of the founders of the Royal Society of Victoria, and has never lost his interest in scientific research during all these years—and yet has left the fact of his earliest and greatest achievement to the accidental finding of a generous stranger in his native land—is an example of modesty as marvellous as it is admirable. To such a man the prompt recognition of his genius by an English learned society specially representative of electrical and telegraphic research will probably be more highly prized in his old age than would have been the pecuniary reward which he pursued with such indifference and abandoned with such unconcern in the prime of life. We sincerely hope it may be so.

CORRESPONDENCE.

ELECTRIC LIGHTING AT A PROFIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was rather surprised to find that all the technical journals of last week's issues had failed to notice an article in the *Pall Mall Gazette* of November 20th, entitled "Electric Lighting at a Profit."

From Mr. Hammond's presence in the deputation which waited on the President of the Board of Trade, I must assume that he agreed with its object, viz., to prove that the Electric Lighting Act is a failure, and that although he may find capitalists willing to put money into electric light enterprises if unfettered by the Act, they will not do so when the Act comes into force.

I notice also Mr. Offor's presence in that deputation, and assume that he finds the same; and I think I may congratulate him on having the *only* instance of an installation worked under the Act. It is general knowledge that the B. T. K. system is only Sir William Thomson's system as promulgated at the Royal Society in 1881, modified in its details and application to meet the requirements of the Electric Lighting Act, and no higher recommendation could be desired. I understand that the directors and management of the South Eastern Brush Company believe that that system will be a commercial success. Undoubtedly the system is right if they have the necessary apparatus to carry it into effect; but upon the question of necessary apparatus I cannot speak, as I do not know.

I believe I am further correct in saying that this system has met with the approval of the Board of Trade.

Presuming such to be the case, through Mr. Offor being one of the deputation, and that he cannot find capitalists willing to help him with other installations, while the Colchester installation has been carried out with company's money, raised before the Electric Lighting Act was passed, we have another argument to bring forward for alterations in Section 27 of the Act, and also in the Provisional Orders, as to questions of the compulsory laying of mains, and the use to which the electric current supplied is to be applied.

The portion of the article, however, to which I wish to draw attention is the system by which Mr. Hammond proposes to make electric lighting profitable—viz., the use of high tensioned currents flowing direct into consumers' premises. Now, "Save me from my friends" is an old saying, and I would certainly say, in the interests of electric light, save me from Mr. Hammond; for he must use currents of a potential that will never be tolerated by the Board of Trade, and which no electrician would dare to recommend for general adoption. No wonder that no private house has yet been lit at Brighton, seeing that a number, say eight or ten lamps, must either be all alight at the same time or not at all. I am aware that in the multiple series system a resistance can be inserted in place of a lamp being turned out; but it would not be economical, and practically the consumer must pay for the current passing through his multiple series, whether he burn the whole or not.

Mr. Hammond has no doubt induced the authorities at Hastings and Eastbourne to give him permission to lay his wires down for more than 21 years, and the details of his agreement with them would be very interesting, particularly to those who have loose capital to invest.

The principle of the Hammond-Wright system is old, but its application and the details of the working out reflect great credit upon the above-named gentleman. It is a system, however, which never could become one for general adoption until a discovery is made whereby a difference of potential of 600 volts and upwards between the line wire and the earth shall not cause either danger of fire or loss or damage to life or limb.

Knowing Mr. Hammond as I do, I feel certain that he will be pained when the impression which this article produces upon the public is made known to him. Would it not be well, while there is yet time, if he would devote his attention to, not necessarily the B.T.K. system, but something of a similar character? for the idea of a direct-running system, whatever potential may be used, has already been practically demonstrated as a failure from a commercial point of view, when continuous supply is required.

That portion of the public which is longing for the electric light has been looking towards Mr. Hammond, but when they see him going in for a scheme which is fraught with danger to life and limb, they rather feel "save us from our friends" and leave us to our enemies, or rather over-careful friends the Board of Trade.—Yours, &c., M.S.T.E.

THE BOARD OF TRADE AND ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Chamberlain's reply to the deputation of the 20th instant encourages discussion upon the terms of the option of purchase under sec. 27 of the Electric Lighting Act, 1882. That there *is* to be an option seems a foregone conclusion. To take the discussion out of the region of pure speculation, I shall take a parallel case in actual experience.

Thirty years ago the financial practicability of railway enterprise in India was purely hypothetical. Experimentally and tentatively some progress had been made. So early as 1849 the East Indian Railway Company had been incorporated by Act of the Imperial Parliament, and an experimental line was soon afterwards made by aid of a subvention from the Government, then that of the East Indian Company. The public were not easily to be convinced that railway works could be maintained under the climatic and physical conditions of the country; and, what is still more to the point, the problem still awaited solution how far the natives would make use of the accommodation to be provided. The Indian Government were desirous of attracting private capital to the enterprise, but for this it was necessary not only to confer a monopoly of powers, but to give a substantial pecuniary guarantee. In consenting to this sacrifice the Government were far-seeing enough to reserve to themselves an option of purchase, but the terms were carefully considered so as to be fair and not repellent to investors.

The final contract of the Indian Government with the East Indian Railway Company was made in 1854. The Govenment guaranteed a minimum dividend of £5 per cent.; surplus profits over that amount in any year were to be shared, one-half to go towards recouping the Government for their outlay on the guarantee, and the other half to increase the dividend. And there was to be an option of purchase by the Government, to be exercised by notice to be given within six months after the expiration of twenty-five years, *or* within six months after the expiration of fifty years, the purchase money to be

"A sum equal to the full amount of the value of all the shares and "capital stock in the company calculated *according to the mean market* "*value in London of such shares or stock during the three years imme-* "*diately preceding* the expiration of the said period of twenty-five years "or the said period of fifty years, as the case might be."

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The terms of the contract so settled in 1854 were the basis of the great undertaking of the East Indian Railway Company, and, it may be said, of the railway system in India, for identical terms were embodied in the Government contracts with all the railway companies in the earlier undertakings in India.

To return to the East Indian Railway. The capital was subscribed on the strength of the contract of 1854, and the undertaking carried out. After some years the profits were found frequently to exceed the guaranteed amount, so that, after dividing the surplus with the Government according to the arrangement, a dividend of ½, 1, or even 2 per cent. over the guaranteed 5 per cent. was paid to the shareholders. The stock improved steadily, and as the time came near for exercising the option stood at about 25 per cent. premium. At this time a momentary panic was caused by a letter to *The Times* calling attention to the existence of the option. But when those concerned had time to look into the matter the terms of the clause were found to have been adjusted with such fairness and foresight that prices quickly resumed the usual quotations. Indeed, when the Government (now the Secretary of State, under the powers of the Act of 1858) finally decided to exercise the option, the only effect on the market was a slight rise, owing to certain fresh advantages conceded by the Government to holders, in order to secure the success of the large financial operation required for meeting the purchase money. The new arrangement (which is confirmed by an Act of the Imperial Parliament, 43 and 44 Vict., cap. 206) took effect from the 1st of January, 1880; and the Government acquired at the price of 25 per cent. premium — perhaps 50 per cent., including the amount expended under the guarantee—an undertaking of proved and increasing value, with the accumulated benefit of experience and successful management, in every respect a remunerative purchase. Indeed, so important was the success attributed to the private management that, under the new arrangement, the company retain a certain interest in the success of the undertaking, which continues to be carried on by the directors of the company on behalf of the Government.

A similar option has been lately exercised in the case of the Eastern Bengal Railway, by notice given in 1883, and under an arrangement confirmed by an Act of the Imperial Parliament in 1884. In some other cases the Government have not found it expedient to exercise the option; and perhaps there are cases, but these are exceptional, where it is never likely to be exercised. Even where the railway has been financially a comparative failure the public advantage has been doubtless a fair compensation for the loss on the Government guarantee. Such cases only illustrate the fairness of the terms of option under which the Government have acquired the undertakings which have proved successful.

In the case of electric lighting there is no question of guarantee. All that is asked is that undertakers for lighting on a large scale shall have the necessary powers, and (consequently) what may be called a *quasi* monopoly. In the case of the Indian railways, the option was part of the consideration for the pecuniary guarantee. The analogy does not indeed justify *any* condition for an option in the case of electric lighting. But, assuming that the principle of clause 27 is unalterable, and the option of purchase a *sine qui non*, the history of Indian railways, extending over the whole period up to and for some years beyond the actual exercise of the option, is a precedent showing the terms on which such an option can be made consistent, not only with the encouragement of private enterprise, but also (what is a point of some importance) with steadiness in the market value of the property affected.

That the Indian Government in new railway undertakings can and does impose harder terms is only an illustration of the difference between a new and untried enterprise and an undertaking on which the profits can be estimated by matured experience. This difference at once disposes of the supposed analogy between electric lighting and gas and water supply. There is the further difference in the case of water companies, that their concessions involve not only a monopoly, strictly so called, but the extensive appropriation of natural resources. False and misapplied analogies, indeed, pervade the whole existing legislation upon electric lighting.—Yours, &c.,

13, Old-square, Lincoln's Inn, R. CAMPBELL.
24th November, 1884.

THE WATT AND HORSE-POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: He would be a very captious man indeed who should say that Professor Adams did not know what a "watt" was, and it was just because such an authority and such an accurate writer made a slip that I used it with such effect to point a moral.

The errors that he uses for his *tu quoque* argument are so evidently printer's or reporter's errors that I regret his having referred to them; for, although I cannot accept the responsibility of them, I should be sorry to call into question the generally wonderful accuracy of your scientific reports. If in the paragraph to which he refers he will substitute "watts per candle" for "watts per minute," he will see what I said. My absence in America prevented my revising the proof, which you would doubtless otherwise have had the courtesy to send me, and so I have had no opportunity to correct the errors which have crept in, and which I now see for the first time.—Yours, &c., W. H. PREECE.

General Post Office, St. Martin's-le-Grand,
24th November, 1884.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When Edwin calls me his angel, I can forgive him for temporarily forgetting that I am of one dimension in *mass*; and when Mr. Herbert Spencer calls everything *force*, we think that a man who has mastered every other science must be pardoned if his mechanics are not up to date; but when one who stands in the very front rank of physical science tells us that "*units of work per second are still units of work*," and that "*revolutions per minute are still revolutions*," I cannot help protesting against the total suppression of Father Time. It seems to me that, accepting the great professor's statement, I am compelled to believe that *units of length per second are units of length* or *velocity* is *distance*. Also *units of momentum per second* must be *units of momentum*, and *units of work per foot* must be *units of work*, although, when I attended lectures and mechanics at Girton, I was led to believe that each of these latter quantities were equivalent to *force*, so that *work* (or energy), *momentum*, and *force* are all the same, and Spencerian philosophy is, after all, triumphant. Having arrived at this result, would it not be better if our leaders would recognise that every one is liable in speaking and letter writing to err in the method of dimensions, and devote their energy to useful work?—Yours, &c., ANGELINA.

SELF-REGULATING MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last week's issue there is a passage on page 26, where the writer falls into an error, previously often corrected, as to the strict chronology relating to the invention of self-regulating machines.

The passage in question runs:—"The invention of compound winding has been claimed for others, but it remains a fact that *the first dynamo machines made practically self-regulating by the compound principle were those made and set to work by Messrs. Crompton for Mr. Coope at Berechurch Hall, near Colchester, in the spring of 1882.*"

The italics are mine that I may better draw attention to the perfect fallacy of the statement.

The first dynamo applied *practically to work* on the compound wound principle was by Dr. Paget Higgs at Greenpoint, Long Island, in 1881. It was a Wood's dynamo, made by the Fuller Company, and by the instructions of Dr. Higgs. The series coils on one side of the machine were replaced by fine wire shunt coils. This machine was subsequently removed to the corner of Chestnut-street and Seventh-street, Philadelphia, by Mr.

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Russell A. Ballero, the well-known financial agent of Boston, and was there exhibited publicly, as well as before Governor Harbranft and the Hon. Mr. Moore, of that city. This machine was driven by a Colt's 6 horse-power disc engine, running at 900 revolutions, steam being got from a 10 horse-power Buxted boiler. Maxim's incandescent lamps were used. Moreover, the machine had been previously shown to Professor Trowbridge, of Harvard College, and the compound principle of winding explained to that scientist by Dr. Higgs, at the Fifth Avenue Hotel, New York.

Four Gramme machines were compound wound under Dr. Higgs's instructions as early as April, 1881, at New York, and are still at work.

In November, 1881, this gentleman shipped to me in Liverpool to my order two compound machines wholly made by him, and one of which is still in my possession in good working order.

In fact, as early as May, 1880, Dr. Higgs was constructing self-regulating machines of an experimental character in Boston, and his first application for letters patent for such is shown by the Commissioners' receipt, now before me, dated 22nd April, 1880. His patents for them, subsequently applied for and granted, bear the date of *April and May, 1881.*

I repeat that self-regulating compound wound machines were in this country and on view in November, 1881, within my own personal knowledge, and I may add, moreover, that as early as December, 1881, a compound machine wound to give a constant current was built under Dr. Higgs's instructions, and employed in America for arc lighting, an application that has never to my knowledge been attempted by any one else. Just a word more. It ought to be remembered, moreover, to the credit of Dr. Higgs that he is not a manufacturer like Mr. Crompton, to whom the writer of the erroneous statement in question is desirous of presenting the patent for self-regulating machines.

Such, however, is the spirit of opposition nowadays, that the toil of an inventor does not by any means end with his invention; it is only beginning with his Sisyphian labour of defending it.—Yours, &c., W. MACGREGOR.

26, Marmaduke-street, Liverpool.

[The passage referred to was carefully worded, and conveys, we think, the idea it was intended to convey. Dr. Paget Higgs's work in this direction has been fully discussed in our columns before, and no one wishes to detract any honour that is his due. It must be remembered that Mr. Edison claims the compound in 1879, a year earlier than is mentioned by Mr. Macgregor. *Vide* Vol. I. *Schellen*, published by Van Nostrand, pp. 490—491.—ED. *E.*]

A GENERAL INDEX.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The suggestion of one of your correspondents in last week's issue as to the preparation of a complete index for all the published volumes of *The Electrician* is a most excellent one. With this at hand and the volumes in question, one would then be able to give oneself a complete course of instruction in any of the branches of electrical science, which have grown from babes to striplings of late years. May I ask whether you are likely to find time amongst your various labours to arrange for the suggestion being given practical effect?—Yours, &c., A. D.

DEMAGNETISING WATCHES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: There are probably a good many of your readers who, like myself, have disabled watches owing to their having become magnetised. If any of your correspondents can give their experience of a simple way for demagnetising such watches, I am sure it will be of much service to many of those engaged in electrical work.—Yours, &c.,

Nov. 26, 1884. HAIRSPRING.

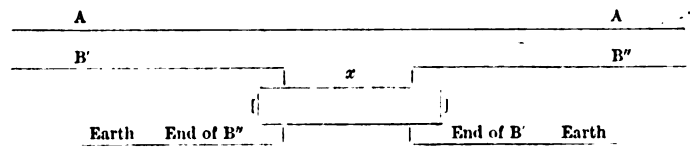
[Several letters on this subject appeared in our last volume, and to these our correspondent might well be referred.—ED. *E.*]

INDUCTION IN TELEPHONE CIRCUITS.

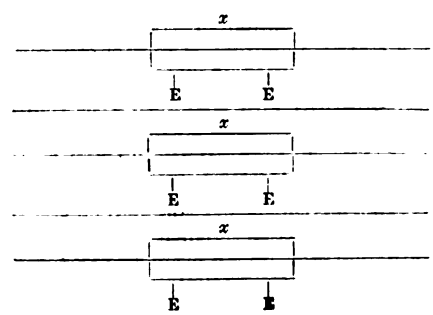
BY F. W. NEALE, STOKE-ON-TRENT.

No one but those who have experienced it can appreciate the worry and trouble telephonic induction has caused to telegraph engineers having charge of telephone circuits. I have the maintenance of two telephone circuits of five miles length each, with four instruments in circuit. The wires are on the same poles throughout, and as they are used by rival traders in the same line of business, the annoyance was intensified. Every means was tried to stop the induction without success, until I devised and carried out the following arrangement. It has stopped the induction, and the two circuits now work quite independently and without divulging each other's trade secrets.

A A and B′ B″ represent two parallel wires of telephone circuits. Under ordinary circumstances every word uttered on A A can be heard on B′ B″, and likewise the other way about. To stop this, cut one of the wires at half the distance, X, and insert an induction coil of two wires wound parallel to each other on the bobbin, as shown below. The length of wires in the induction coil must be regulated to the length of wire on the circuit on which it is to work.

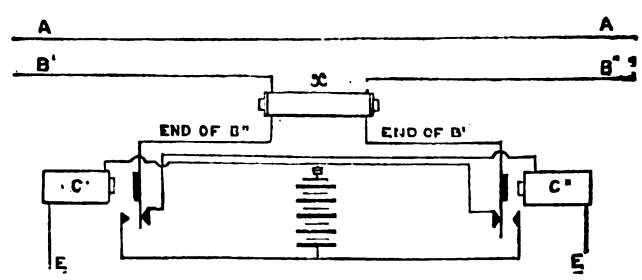


Any currents passing along B″ will pass to E at X, but will induce opposite currents in B″, and *vice versâ*. At the same time, the inductive action on A A in one half the line B′ will kill the inductive action on A A in the other half B″. This simple device can be applied to telephone circuits in different ways. It may sometimes be advisable to divide a circuit into three, and put in two induction coils. It can probably be arranged better where wires are put one over the other vertically thus, with the coils inserted alternately.



A magneto bell will ring well through the coil to the other end, with the current induced at X from either end, and will also ring well through two induction coils put in one circuit.

Where bells are rung with battery currents, I have worked them under the following arrangement:—



It is the induction coil inserted at half distance on B′B″ with an addition of two relays C′ and C″. A ringing current sent from either B′ or B″ pulls up the armature of C′ or C″, and puts a relay of battery power on to the other half the circuit, which rings the bell.

Mr. Brown, of the Walsall Electrical Company, to whom I communicated the above arrangement, in order that he

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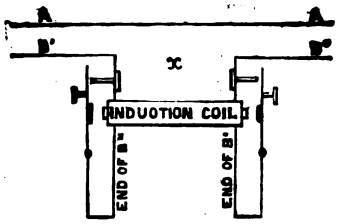
might also give it a trial, suggests the following simpler arrangement for circuits ringing with batteries, which has the advantage of dispensing with the relay of battery power.



It will be seen that a ringing current passing through the coil from either end pulls up the two armatures, thereby cutting off the earth and putting the circuit through at X so long as the ringing current is held on.

I may say that I have made no special secret of this arrangement, and after I had satisfied myself with nearly two years' trial of the second arrangement, I communicated the result to several of my friends, all of whom bear testimony to its efficiency. Any one troubled with induction is therefore at liberty to try it, as there is no intention of patenting it. It also has the advantage of improving the articulation in the telephone.

THE THEORY OF ALTERNATING CURRENTS.*

BY J. HOPKINSON, F.R.S.

(CONCLUDED FROM PAGE 36.)

V†. In all that precedes it is assumed, not only that γ is constant, but that the copper conductor of the armature is the only conductor moving in the field. If there be iron cores in the armature, we shall approximate to the effect by regarding such cores as a second conducting circuit. Slightly changing the notation, let L be coefficient of self-induction of the copper circuit, N coefficient of self-induction of the iron circuit and R^1 its resistance, I^1 the magnetic induction of the field magnets upon the iron circuit, and M the coefficient of mutual induction of the two circuits, y the current in the iron. The equations of motion are obtained from the expression for the energy, viz.,

$$\tfrac{1}{2}\{L x^2 + 2 M x y + N y^2 - 2 I x - 2 I' y\}$$

and are

$$L x' + M y' + R x = \frac{dI}{dt} = \frac{2\pi A}{T} \cos. \frac{2\pi t}{T}$$

$$M x' + N y' + R' y = \frac{dI'}{dt} = \frac{2\pi B}{T} \cos. \frac{2\pi t}{T}$$

for in general the iron cores and the copper conductor are symmetrically arranged. Assume

$$x = a \sin. \frac{2\pi t}{T} + b \cos. \frac{2\pi t}{T}$$

$$y = a' \sin. \frac{2\pi t}{T} + b' \cos. \frac{2\pi t}{T}$$

and substitute in the equations of motion, we have the following four equations to determine the constants, $a\ b\ a'\ b'$

$$a \frac{2\pi L}{T} + a' \frac{2\pi M}{T} + R b = \frac{2\pi A}{T},$$

or

$$a L + a' M + b \frac{T R}{2\pi} = A$$

and

$$b L + b' M - a \frac{T R}{2\pi} = 0$$

$$a M + a' N + b' \frac{T R'}{2\pi} = B$$

$$b M + b' N - a' \frac{T R'}{2\pi} = 0$$

These equations contain the solution of the problem, but are too cumbersome to be worth while solving generally; we will, however, prove the statements made in the lecture before the Civil Engineers.

1st. Compare short circuit and open circuit, that is $R = 0$ very nearly, and $R = \infty$. In the former case we find that work done in the iron is diminished, and if $B = \frac{A M}{L}$ we have the paradoxical result that there are no currents induced in the iron of the cores and no work is required to drive the machine. This, of course, can never actually occur, because R can never absolutely vanish. It suffices to show, however, that the current in the copper circuit may diminish the whole power required to drive the machine to an amount less than the power required to drive the machine on open circuit.

2nd. The other statement related to the effect of the currents in the iron upon the currents produced in the copper circuit. Assume that the effect is a small one, for a first approximation. Neglect it, that is, treat the currents in the iron and the current in the copper as independent of each other, and then see how each would disturb the other.

The first approximation then is

$$\begin{cases} a = \dfrac{A L}{L^2 + \frac{T^2 R^2}{4\pi^2}}; & a' = \dfrac{B N}{N^2 + \frac{T^2 R'^2}{4\pi^2}} \\ b = \dfrac{A \frac{T R}{2\pi}}{L^2 + \frac{T^2 R^2}{4\pi^2}}; & b' = \dfrac{B \frac{T R'}{2\pi}}{N^2 + \frac{T^2 R'^2}{4\pi^2}} \end{cases}$$

If we substitute these in the general equations as corrections, we have

$$\begin{cases} a L + b \frac{T R}{2\pi} = A - \dfrac{B N M}{N^2 + \frac{T^2 R'^2}{4\pi^2}} \\ -a \frac{T R}{2\pi} + b L = -\dfrac{B \frac{T R'}{2\pi} M}{N^2 + \frac{T^2 R'^2}{4\pi^2}} \end{cases}$$

which shows that the disturbing effect of each circuit upon the other is to diminish the apparent electromotive force, but to accelerate its phase.

VI. A very similar problem is that of secondary generators or induction coils, whether used for the conversion of high potentials to low, or the reverse. To treat it generally, taking the magnetisation of the iron cores, which are always used, as a non linear function of the currents in the coils would be a matter of much difficulty; we therefore assume, as is usual, that the coefficients of induction are constants, noting in in passing that this is not strictly the fact, though it is very nearly the fact, when the cores are not saturated and when the lines of magnetic induction pass through non-magnetic space.

Let, then, R r be the resistances of the primary and secondary circuits,
L coefficient of self-induction of the primary,
N coefficient of self-induction of the secondary,
M coefficient of mutual induction of the two circuits,
x and y the currents in the two circuits at time t,
X the electromotive force applied in the primary circuit by an alternate-current dynamo machine or otherwise,

the equations of motion will be

$$\left.\begin{aligned} L x' + M y' + R x &= X \\ M x' + N y' + r y &= 0 \end{aligned}\right\}$$

Various assumptions may be made as to X, but that most likely to be adopted in the practical work of secondary generators is that X is kept so adjusted that

$$x = A \cos. n t \text{ where } n = \frac{2\pi}{T}$$

and to inquire how X will depend on the resistances

$$N y' + r y = n A M \sin. n t$$

* Paper read before the Society of Telegraph Engineers and Electricians on November 13th.

† *Vide* also *Encyclopædia Britannica*, article "Lighting."

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$$y = \frac{n\,A\,M}{n^2\,N^2 + r^2}\,(-n\,N\cos.\,n\,t + r\sin.\,n\,t)$$

$$X = A\left[\left\{-n\,L + \frac{n^3\,N\,M^2}{n^2\,N^2 + r^2}\right\}\cos.\,n\,t + \left\{\frac{M^2\,n^2\,r}{n^2\,N^2 + r^2} + R\right\}\cos.\,n\,t\right]$$

As in the case of the dynamo machine, the work done in the secondary circuit is greatest when $r = n\,N$. The expression for X serves to show that when the secondary is short-circuited a *lower* electromotive force of the generating circuit is required than when it is on open circuit. In induction coils the electrostatic capacity of the coils themselves has important effects. An illustration of the effect of electrostatic induction is found in the old-fashioned Ruhmkorff coils. These were not wound symmetrically, but in such wise that one end of the secondary coil was on the whole towards the inside, the other towards the outside of the bobbin. In such coils a spark to earth may be obtained from the outside end, but not from the inside. The reason is that the outer convolutions have smaller electrostatic capacity than the inner ones. The terminals may be made to give equal sparks by the simple expedient of laying a piece of tinfoil around the whole coil and connecting it to earth.

VII. Some time ago Dr. Muirhead told me that he had observed that the effect of an alternate current machine could be increased by connecting it to a condenser. This is not difficult to explain: it is a case of resonance analogous to those which are so familiar in the theory of sound and in many other branches of physics.

Take the simplest case, though some others are almost as easy to treat. Imagine an alternate current machine with its terminals connected to a condenser; it is required to find the amplitude of oscillation of potential between the two sides of the condenser. Let $R\,\gamma$ be the resistance and self-induction of the machine, $E\sin.\frac{2\pi t}{T}$ its electromotive force, C the capacity of the condenser, V the difference of potential sought, and x the current in the machine, then

$$C\,V' = x$$

and

$$\gamma x + R\,x = E\sin.\frac{2\pi t}{T} - V$$

whence

$$\gamma x' + R\,x' = \frac{2\pi}{T}E\cos.\frac{2\pi t}{T} - \frac{x}{C}$$

$$x = \frac{\left\{1 - C\gamma\left|\frac{2\pi}{T}\right|^2\right\}\cos.\frac{2\pi t}{T} + RC\frac{2\pi}{T}\sin.\frac{2\pi t}{T}}{\left\{1 - C\gamma\left(\frac{2\pi}{T}\right)^2\right\}^2 + R^2C^2\left(\frac{2\pi}{T}\right)^2}\cdot\frac{2\pi E\,C}{T}$$

$$V = \frac{\left\{1 - C\gamma\left(\frac{2\pi}{T}\right)^2\right\}\sin.\frac{2\pi t}{T} - RC\frac{2\pi}{T}\cos.\frac{2\pi t}{T}}{\left\{1 - C\gamma\left(\frac{2\pi}{T}\right)^2\right\}^2 + R^2C^2\left(\frac{2\pi}{T}\right)^2}\cdot E$$

Amplitude of V is therefore

$$= \frac{1}{\sqrt{\left\{1 - C\gamma\left(\frac{2\pi}{T}\right)^2\right\}^2 + R^2C^2\left(\frac{2\pi}{T}\right)^2}}\cdot E$$

Now suppose E = 100 volts, the machine would light up an incandescent lamp of about 69 volts; let $T = \frac{1}{200}$ second, C = 100 microfarads, and $\frac{2\pi\gamma}{T}$ = eight ohms, and $R = \frac{1}{10}$ ohm, all figures which could be practically realised, we have amplitude of V = 80 E roughly, or the apparent electromotive force would be increased eighty-fold.

We now return to the principal subject of the present communication. Some attempts have been made to verify the proposition that two alternate-current machines can be advantageously connected parallel, but I believe, till recently, without success. I had no convenient opportunity for testing the point myself till last summer, when I had two machines of De Meritens, intended for the lighthouse of Tino,* in my hands. I have made no determinations of the constants of these machines, but between three and four years ago I thoroughly tested a pair of similar machines now in use at a lighthouse in New South Wales.* Each machine has five rings of sixteen sections, and 40 permanent magnets. The resistance of the whole machine as connected for lighthouse work (a single arc) was 0·0313, its electromotive force (E) when running 830 revolutions per minute, 95 volts and $\left(\frac{2\pi\gamma}{T}\right)^2$ = 0·197 ohms. It was further remarked that the loss of power was least with a maximum load, as is shown in the following table:—

Power applied as measured in belt	3·1,	4·8,	5·6,	6·5,	5·4
Electric power developed ...	0·7,	3·4,	4·3,	5·7,	3·4
Mean current in amperes ...	7·7,	38·6,	51·7,	73·6,	151

The result illustrates well the conclusion arrived at in Problem V. above.

Last summer the two machines for Tino were driven from the same countershaft by link bands at a speed of 850 to 900 revolutions per minute; the pulleys on the countershaft were sensibly equal in diameter, but those on the machines differed by rather more than a millimetre, one being 300, the other 299 mm. in diameter (about); thus the two machines had not when unconnected exactly the same speed. The pulleys have since been equalised. The bands were of course put on slack as practicable, but no special appliance for adjusting the tightness of the bands was used. The experiment succeeded perfectly at the very first attempt. The two machines, being at rest, were coupled in series with a pilot incandescent lamp across the terminals, the two bands were then simultaneously thrown on; for some seconds the machines almost pulled up the engine. As the speed began to increase, the lamp lit up intermittently, but in a few seconds more the machines dropped into step together, and the pilot lamp lit up to full brightness and became perfectly steady and remained so. An arc lamp was then introduced, and a perfectly steady current of over 200 amperes drawn off without disturbing the harmony. The arc lamp being removed, a Siemens electro-dynamometer was introduced between the machines, and it was found that the current passing was only 18 amperes, whereas, if the machines had been in phase to send the current in the same direction, it would have been more than ten times as great. On throwing off the two bands simultaneously, the machines continued to run by their own momentum, with retarded velocity. It was observed that the current, instead of diminishing from diminished electromotive force, steadily increased to about 50 amperes, owing to the diminished electrical control between the machines, and then dropped off to zero as the machines stopped. Professor Adams will, I hope, give an account of experiments he has tried with me, and on other occasions, at the South Foreland. With De Meritens' machines I regard coupling two or more machines parallel as practically the best way of obtaining exceptionally great currents when required in a lighthouse for penetrating a thick atmosphere.

(Note added 22nd November, 1884).

My attention has only to-day been called to a paper by Mr. H. Wilde, published by the Literary and Philosophical Society of Manchester, Dec. 15th, 1868; also *Phil. Mag.*, Jan., 1869. Mr. Wilde fully describes observations of the synchronising control between two or more alternate current machines connected together. I am sorry I did not know of his observations when I lectured before the Institution of Civil Engineers, that I might have given him the honour which was his due. If his paper had been known to those who have lately been working to produce large alternate current machines, it would have saved them both labour and money.

* The engines, dynamos, lamps, optical apparatus, and lanterns of both these lighthouses have been supplied by Messrs. Chance Brothers and Co.

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THE SILENT ELECTRIC ARC.

BY ANTHONY C. WHITE, S.B.

If we take two carbon rods through which a current of electricity of sufficient strength to produce an electric arc is passing and gradually separate them, we shall find that a disagreeable hissing sound will be produced in connection with the electric light. When the separation has reached a certain amount the noise will suddenly disappear, and the arc will remain silent until the carbons are separated enough to open the circuit. The cause of the hissing has never to my knowledge been satisfactorily explained.

In August of 1883, while experimenting upon the electric arc, I made some observations on the silent electric arc to see if it would not throw some light upon the cause of the hissing. The apparatus used in this investigation I am not at liberty at present to describe. The measurements of current strength and E.M.F. were made with an Ayrton and Perry's ammeter and voltmeter.

In the measurements made in August of 1883 I did not measure the separation of the carbons. I have since improved the apparatus, especially the lamp, and have employed a ten-light Weston dynamo in place of the five-light machine first used. The working of the lamp was everything that could be desired. The results of my observations are as follow :—

WALLACE CARBON, 11mm. in diameter. August 1883.

Current in amperes.	E.M.F. in volts.	Current in amperes.	E.M.F. in volts.
7·0	54·7	11·8	44·7
8·0	50·7	12·0	50·4
8·6	46·6	13·8	45·6
10·0	47·1	14·5	45·6
11·0	50·4	16·3	43·7
11·0	44·7	18·0	46·9

TABLE I.

WALLACE CARBON, 11mm. in diameter. May 16th, 1884.

Current in amperes.	E.M.F. in volts.	Resistance in ohms.	Separation in mm.
5·94	37·01	6·23	1·23
6·42	40·97	6·38	1·66
6·71	38·19	5·69	1·13
6·89	42·41	6·16	1·33
9·53	40·25	4·22	1·67
10·59	39·94	3·77	1·77
11·57	39·42	3·41	1·77
13·59	40·61	2·99	1·93
15·64	41·12	2·63	2·47
16·85	41·48	2·46	2·33
20·30	42·15	2·07	2·77

TABLE II.

WALLACE CARBON, 11mm. in diameter. June 16th, 1884.

4·98		40·0			1·1	
4·98	4·98	40·5	40·4	8·11	1·3	1·2
4·98		39·6			1·2	
5·62		41·5			1·55	
5·62	5·62	41·4	41·3	7·35	1·25	1·35
5·62		41·0			1·25	
6·08		41·7			1·25	
6·38	6·21	39·6	41·5	6·68	1·50	1·45
6·17		43·1			1·60	
7·37		40·0			1·50	
7·55	7·49	39·5	39·6	5·29	1·50	1·50
7·55		39·4			1·50	
8·38		39·8			1·40	
8·38	8·38	39·0	39·5	4·71	1·50	1·43
8·38		39·6			1·40	
10·13		40·6			1·60	
10·13	10·45	40·0	40·7	3·90	1·60	1·73
11·14		40·0			1·85	
10·40		41·5			1·85	
12·34		42·0			2·05	
12·43	12·34	39·6	41·2	3·34	1·70	1·95
12·24		42·0			2·10	
12·89	12·94	42·0	40·5	3·13	2·25	1·98
12·98		39·0			1·70	
14·77		41·5			2·30	
13·90	14·19	42·0	41·9	2·95	2·20	2·27
13·90		42·2			2·30	
15·51		41·6		2·68	2·40	

TABLE III.

CARRÉ CARBON, 7mm. in diameter. June 18th, 1884.

Current in amperes.	E.M.F. in volts.	Resistance in ohms.	Separation in mm.
3·78	39·8	10·53	0·85
4·88	38·0	7·79	1·00
6·49	43·6	6·72	1·30
8·10	42·2	5·21	1·50
10·91	46·6	4·27	2·35

TABLE IV.

WALLACE 13mm. carbon. June 18th, 1884.

4·98	40·4	8·11	1·40
7·92	37·8	4·77	1·60
9·30	42·7	4·59	1·80
10·50	40·4	3·85	2·00
12·06	38·6	3·20	2·00
14·82	43·2	2·91	2·95
15·51	40·4	2·60	2·85
17·86	40·4	2·26	2·75

TABLE V.

WESTON 10mm. carbon. June 19th, 1884.

4·75	41·2	8·68	1·00
5·62	41·7	7·42	1·70
7·32	38·0	5·19	1·40
7·64	41·2	5·39	2·35
7·92	41·7	5·27	1·70
8·70	39·1	4·50	1·20
8·70	39·1	4·50	1·20
10·86	41·7	3·84	1·70
10·96	39·6	3·61	2·00
12·75	42·9	3·37	2·10
15·03	41·5	2·76	2·05
15·28	42·2	2·76	1·90

TABLE VI.

JABLOCHKOFF 4mm. carbon. June 19th, 1884.

3·60	39·8	11·06	—
3·55	38·8	10·93	0·40 0·60
3·69	—	—	0·80
3·78	39·5	10·45	1·80
3·78	39·5	10·45	1·90

CARRE 7mm. carbon. July 17th, 1884.

8·00	40·28	5·04	1·0*
8·83	42·94	4·86	1·3
10·12	45·41	4·49	1·6

SAME CARBON, July 24th, 1884.

4·51	37·81	8·38	0·6*
4·78	39·1	8·18	0·7
6·72	41·6	6·19	0·8

BRUSH 11mm. carbon. July 28th, 1884.

15·73	45·60	2·90	2·1*
15·73	46·55	2·96	2·9
15·55	47·60	3·06	3·0

SAME CARBON, July 29th, 1884.

5·44	38·44	7·07	1·07*
10·81	41·91	3·88	1·83
15·55	45·75	2·94	3·00

WALLACE 11mm. uncoated carbon. July 29th, 1884.

5·80	40·47	6·98	1·00
8·83	39·98	4·53	1·27
11·60	41·90	3·61	2·12
14·44	42·43	2·94	2·28

BOULTON 11mm. carbon. July 30th, 1884.

5·15	39·84	—	—
6·35	39·18	6·17	1·00
7·77	40·22	5·18	1·30
9·75	42·50	4·36	1·90
12·70	43·23	3·40	2·20
15·64	43·51	2·78	3·13

BOULTON 11mm. carbon. June 20th, 1884.

15·83	52·44	—	4·6
15·69	52·25	—	4·9
15·74	52·44	—	4·3

* The columns marked with an asterisk indicate the averages of three observations.

I have plotted curves for some of the measurements. Plate I. shows the increase of separation with the current strength for the silent arc in the case of the Wallace 11mm. carbon and the Carré 7 mm. Plate III. is from a series of measurements made 30th July on the Boulton 11 mm. carbon. Plate II.

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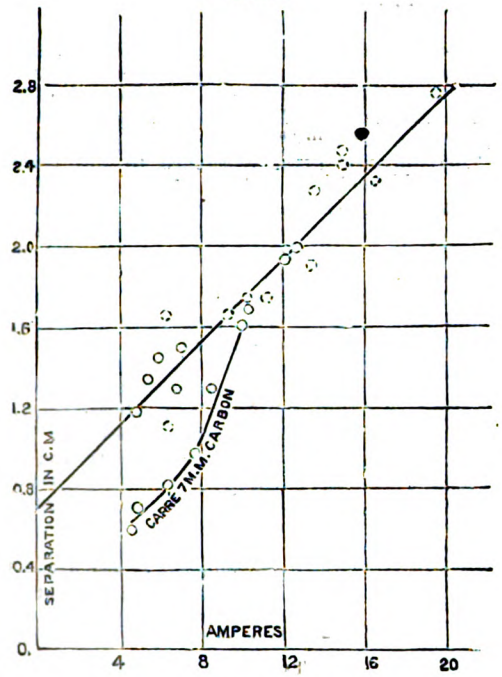
shows the relation between the resistance and current strength for the silent arc. Points marked o' were obtained from the equation $x\,y = 40{\cdot}8$, which is the equation of a hyperbola. The proximity of these points to the curves proves conclusively

PLATE I.



that it is hyperbolic; and since it is a hyperbola the resistance of the silent arc is inversely as the current strength.

From my measurements I draw the following conclusions:—

1st. The E.M.F. of the silent arc is constant, regardless of the current strength.

2nd. The resistance varies inversely as the current strength.

3rd. The E.M.F. is independent of the size of the carbons.

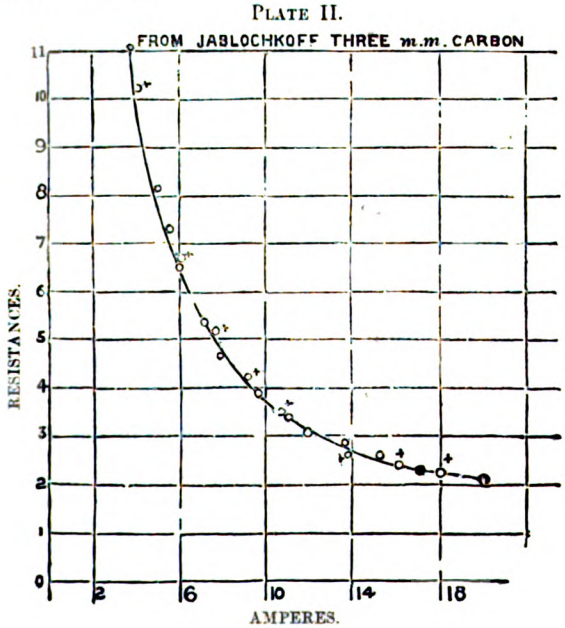
4th. For the same carbons the separation varies in direct ratio to the current strength.

5th. The value of the E.M.F. is somewhat affected by impurities in the carbons.

6th. The separation is considerably affected by impurities in the carbons.

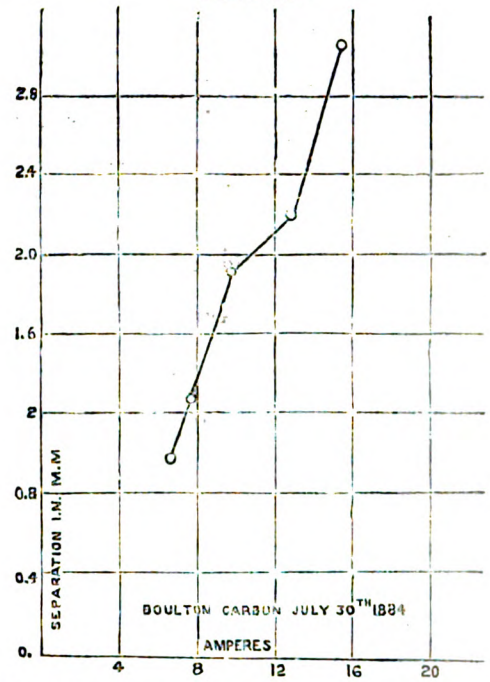
7th. The position for silence is a well-defined point, the E.M.F. falling several volts as soon as hissing begins after the arc has been silent.

PLATE II.



I have never succeeded in obtaining a silent arc with a current less than 3·55 amperes, when the resistance was 10·93 ohms. This was with a Jablochkoff carbon 4mm. in diameter. By examining the curve on Plate II. it will be seen why it is so difficult to maintain a silent arc with a weak current, for a small reduction of the current strength when small will cause a great increase in the resistance of the arc.

PLATE III.



It will be seen by examining the tables that the E.M.F., as a rule, increased somewhat with the current strength. This is due partly to the resistance of the carbon rods. In all the preceding measurements the E.M.F. due to this resistance has not been eliminated. It is evident this error is not a constant, but varies with the current. I do not think a rise of more than two volts can be attributed to the resistance of the carbons. The higher readings, which cannot be accounted for in this way, may be due to impurities.

ON THE ELECTRIC LIGHT.*

BY ALFRED RICHARD SENNETT, A.M.I.C.E.

The production of electricity, and its subsequent conversion into light, is to-day another example of "directing the great sources of power in nature for the use and convenience of man," and, as such, falls within the category of works undertaken by the civil engineer. It is the purport of the author briefly to explain in what electric lighting consists, the relation which it bears to other methods of illumination, and to describe some of the apparatus employed in its production and utilisation. Electric lighting, then, consists in converting energy, whether potential or kinetic, into light through the intervention of that form of energy known as electricity. This transmutation by the ordinary method, namely, by employing a steam engine to give motion to a magneto or dynamo-electric generator, is somewhat circuitous. Nevertheless, although the best engines yield but about one-ninth part of the total energy residing in the coal consumed, and loss may and does take place in the transmission of the kinetic energy of the motor to the generator—in this latter in the transport of the electric energy to the focus of illumination, and, indeed, at the focus itself—yet in point of economy it compares most favourably with all other methods of illumination. The only reason which can be given for this is, that through the agency of electricity a greater concentration of heat can be effected than by any other means, and because the intensity of the light emitted from an incandescent body rises much more rapidly than the temperature. Very different figures have been assigned to the temperature of the poles of the electric arc; thus Professor Rosetti, after a long series of experiments, gives +3,200° to 2,500° Centigrade; Professor Dewar +6,000° Centigrade; Professor Becquerel +2,000° Centigrade. Now, taking the lowest of these, and assuming the law of Becquerel to hold good for high temperatures, each unit of area of the electrode would emit a light 191,000,000 times as intense as that of a body at 916° Centigrade (melting point of silver). The most simple method of

* Paper read at a Supplementary Meeting of the Institution of Civil Engineers.

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conversion is by chemical action, exemplified in galvanic batteries, the efficiency of which, as will be seen by comparing the energy obtained by the combination of zinc in various cells by Julius Thomsen, with the energy of combination of a given weight of zinc with oxygen, is very high ; but the relatively high price of the fuel consumed, and the fact that the heat procurable from a given weight of zinc is only about one-seventh that obtainable from coal, prohibits its use. Many attempts to attain the end more directly have been made (for example, thermo-electric generators, gas, batteries, &c.), but at present not one is in a position to compete with the dynamic method. Now, since loss is always consequent upon the conversion of one form of energy into another, it should be the aim of the engineer both to reduce the number of conversions and to diminish each to a minimum, so that the highest possible percentage of the original store of energy may be obtained at the focus of illumination. By loss here is meant energy not expended in the desired direction ; of course no actual loss can take place. The conditions of electric lighting may be represented by a simple case of dynamics, for in both the reclaimed energy is due to fall of potential—in the one case electrical, in the other mechanical. Take the simplest example—that of a falling weight—and let the machine in one case be a man, and in the other any dynamic generator of electricity. The man produces a great difference of potential by carrying the weight up, say, a monument ; the other generator effects the same by mechanically cutting lines of magnetic force. The fuel for the first machine is provided by fat and muscular tissues, for the second by the potentiated radiant energy of other ages. This difference of potential is in the one case expressed in pounds, in the other in volts. The weight rests at the top of the monument ; the flagstone offers too great a resistance for it to overcome ; the circuit of the machine remains open ; the cold air offers too great a resistance for it to overcome. Imagine a number of sheets of, say, sackcloth to be suspended horizontally from top to base of the monument ; imagine the external circuit of the machine to be composed of a like number of units of length. The weight is cast off the monument, it overcomes the resistance of each stratum of sackcloth, and forcing its way through, imparts to each a modicum of heat. The circuit is closed, the electromotive force overcomes the resistance of each unit of length, and, forcing a current through, imparts to each a modicum of heat. On the arrival of the weight at the base, it has the same potential as the earth ; on arrival of the current at the other pole it has the same potential as this latter. In both cases the work done, or heat produced, which is the same thing, will have a relation to the amount of fuel consumed dependent upon the efficiency of each machine. The efficiency of the man depends upon his weight ; that of the generator upon dispositions too numerous to mention here. But this heat has been wasted so far as the production of light is concerned, for although a sufficient quantity was present, it was not sufficiently concentrated to produce light. Now reduce the resistance in circuit by diminishing the number of strata of sackcloth, or by lessening the thickness of each. Also reduce the resistance in circuit by diminishing the number of units of length or increasing the sectional area of each ; substitute for the lessened resistance of the sackcloth a sheet of iron, and for the diminished resistance of the conductor an arc ; the weight again falls, and meeting with scarcely any resistance, except at the plate, most of its momentum is utilised in penetrating the iron and producing a flash of light. The current again flows, and meeting with scarcely any resistance, other than that of the arc, most of its energy is used in producing light. There is yet one thing more—the inverse or counter electromotive force of the arc. This may be represented by the momentum of a stone thrown upwards and meeting the falling weight just as it enters the iron plate. Fig. 1 shows this fall of potential when a steam engine is employed. The fall is due to the following efficiencies :—Steam engine, 11 per cent. ; gearing, 95 per cent. ; dynamo-electric generator, 80 per cent. ; cables, 93 per cent. ; and carbons, 94·4 per cent. The ordinate G H represents the potential energy of coal (that is, the energy with which the carbon wishes to unite with the oxygen of the air). In this case let G H represent 1lb. of coal = 800·0 cent.-units of heat × 1,390lbs. = 333·6 h.-p. per minute = 5·56 h.-p. per hour. Under the conditions shown the energy expended in the arc will be 0·4 h.-p., which will yield a light (in an arc of great power) equal to about 800 standard candles for one hour. If the whole energy had been transmitted to the generator, a light equivalent to about 7·420 candles would have been produced, whilst if the whole fall of potential had taken place in the arc, a light of the intensity of about 11,120 candles for an hour would have been the result.

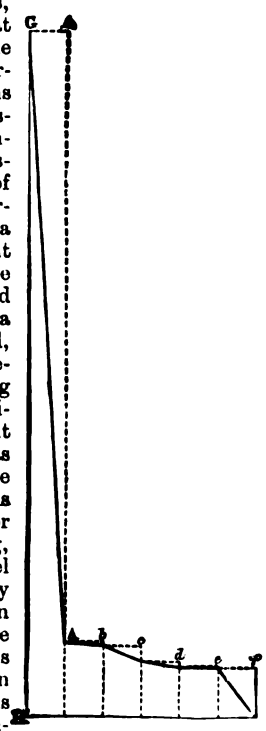

Fig. 1.

The Arc.—Of the several methods of converting electrical energy into light, the two most frequently employed are known respectively as the arc and incandescence methods. The light in the former method—that of Sir Humphrey Davy (1810)—is produced by causing the current to traverse a small space between carbon points. This opposing great resistance to the passage of the current causes intense heating of the electrodes, and light is the result, due, first, to the incandescence of the solid carbon points ; and, secondly, to the stream of incandescent carbon particles which forms the arc. The light emitted by the former, which is by far the more intense, is similar to that of the sun in composition ; whilst that of the latter is extremely rich in the more refrangible rays, and gives to electric light its characteristic tint. On account of this disintegration and oxidation of the carbon electrodes, it is necessary, in order to produce a continuous light, to provide means for automatically feeding the electrodes, and this is generally effected by a piece of mechanism known as a regulator, or arc lamp.

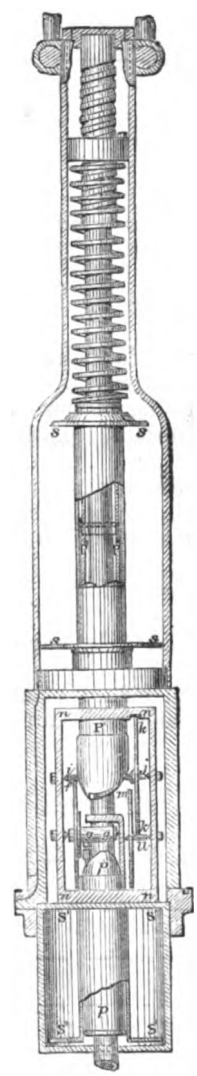
Fig. 2.

Regulation of the Arc.—The following are among the essentials of a good regulator or lamp :—Its working parts should be as few as possible, and easily accessible for cleaning, &c. It should be so simple that repairs to it can be entrusted to workmen of ordinary intelligence. The works should be well covered, and placed above the arc, so as to be proof against the entry of ash and small particles of carbon. It should be capable of being so adjusted as to allow a definite strength of current to pass if one lamp only is to be placed in circuit ; or to maintain a definite resistance of arc—in other words, to preserve a constant difference of potentials between the two electrodes, if several lamps are to be worked in series. If the lamp does not fulfil this requirement, more current will pass, more motive power will be absorbed, heating of the machine will ensue, and the whole system will be subjected to a greater strain than that for which it was originally intended. The moment of inertia of the controlling parts should be small, so that it may promptly respond to any variation in the required conditions. It should be capable of imparting a delicate feed to the carbons at short intervals of time. Its mechanism when not in the act of feeding should be locked, so that no swinging, jarring, or bodily movement of the lamp will cause it to feed with a normal arc. The lamp should be provided with both a coarse and a fine adjustment, in order that it may answer immediately to any sudden lengthening of the arc (such as that, for example, which frequently occurs from the falling off of a portion of the electrodes) without the necessity of waiting for a prolonged action of the fine adjustment.

The number of forms of mechanism which have been devised for the purpose of effecting the necessary feed of the carbons is very great, and it is extremely interesting to trace their development towards perfection. The author will, however, explain only that apparatus appertaining to electric lighting with which he is connected. Diagrams showing the disposition of the parts of the lamps and the method of connection are given in Figs. 2, 3, 4, 5, and 6.

In order to obtain delicacy in the feed, most lamps hitherto have been provided with long trains of wheel-work, with the object of lessening as much as possible the work done by the governing device, and of reducing a comparatively coarse feed of the governing

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device to a very fine one of the carbons themselves. The feed is generally governed by the movement of heavy armatures or solenoid cores. Two great disadvantages in this method of governing are: first, that the moment of inertia of both the train and the armatures is too great to allow the system to respond to very slight deviations from the required conditions; and, secondly, that as the force acting between the magnet and its armature varies as the square of the distance through which it acts, the power of the governing-device varies greatly with its position. Consequently, when the governing device is actuated by any deviation from the required conditions of the system, it can never cease to act exactly when the required condition has been regained, but must continue to act until a deviation has been produced in the opposite direction. For the governing device the author employs a very light and delicately suspended or balanced electro-magnet, or solenoid, working under the influence of controlling electro-magnets or solenoids. In Figs. 2, 3, 4, 5, and 6, *a*, *b*, *c*, represent the delicately balanced electro-magnet, and to which for brevity the author has given the name "reaction or reciprocal armature." The poles which control the action of this reciprocal armature are formed by the prolongation of the plungers *p*, *p*, and P′, P′, of the solenoids.

The reciprocal armature has not a continuous paramagnetic core, but consists of two cores separated by diamagnetic material. The core *b*, *c*, has wound upon it a wire forming a continuation of the wire upon the solenoid S′, S′, S′, S′, which is so connected as to form a shunt or derived circuit to the arc; that is, the current

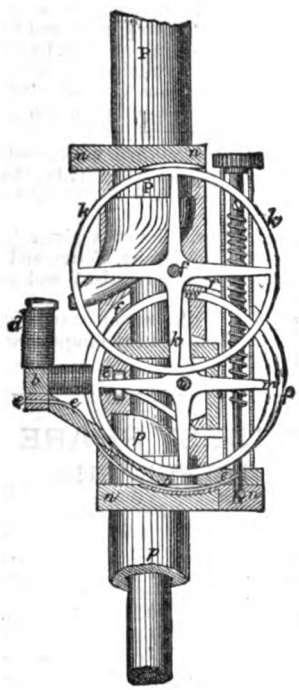

FIG. 3.

flowing in the circuit thus formed does not pass through the arc. The arrangement is very similar to the by-pass upon an ordinary gas-main. The wire coiled upon *a*, *b*, virtually forms part of the main circuit, namely, the circuit through both the arc and the by-pass, although for constructional reasons it is made to form a derived circuit to the solenoid *s*, *s*, *s*, *s*, in order that a much finer wire may be employed. Attached to the diamagnetic portion of the armature is the brake-spring *e*, *e*, *e*. The plungers *p*, *p*, and P′, P′, project from the top and bottom of the gearing frame, and play within the solenoids *s*, *s*, *s*, *s*, S′, S′, S′, S′. Consequent upon the strength and sensibility of the reciprocal armature, the author has been enabled to employ a very short train; it consists of the first wheel *f*, *f*, connected to the pinion *g*, *g*, which gears with the rack through the intervention of a rachet wheel, in order that the rack may be raised without the necessity of revolving the train backwards. This first wheel gears with the pinion *i*, keyed to the arbor *j*, upon which is mounted the wheel *k*, *k*, gearing with the small pinion *l*, *l*. This latter carries the aluminium brake-wheel *m*, *m*, the total weight of which, together with the pinion, is about one-tenth of an ounce.

The action of the lamp is as follows:—when no current is flowing the gearing frame *n*, *n*, *n*, *n*, rests nearly upon the bottom of the framing of the lamp, in which position the carbons are in contact. Upon a current passing through the lamp the plunger P, P, is drawn up into the solenoid *s*, *s*, *s*, *s*, and by this motion the arc is formed; the current now flows through *s*, *s*, *s*, *s*, *a*, *b*, and the arc, and by the other route through S′, S′, S′, S′, and *c*, *d*. The directions of winding are such that repulsion takes place at *a*, and attraction at *c*, and these may be made to just balance each other with a given difference of potentials between the electrodes. In order, however, that the lamp may be adjusted to maintain any length of arc at will, the attraction at *c* is made to be slightly in excess of the repulsion at *a*, in order that a certain amount of torque may be imparted to the system, the amount of which, however, may be regulated by the tension of an adjusting spring.

By this means the author has been enabled to employ a governing device, whose power and sensibility are independent of its position in relation to the controlling poles, and thus the objections above referred to have been eliminated, the motion of the feed-mechanism being arrested immediately the required conditions are fulfilled. In order to reduce to a minimum the electrical energy

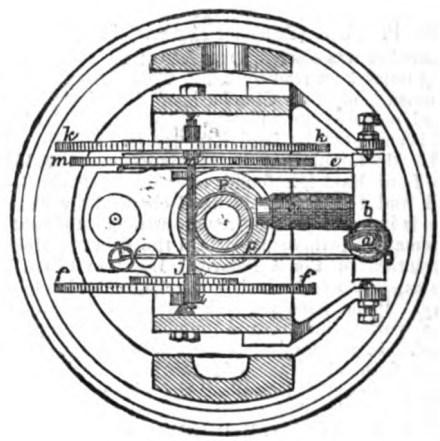

FIG. 4.

necessary to perform the mechanical operations of the lamp, the solenoid *s*, *s*, *s*, *s*, is assisted in its work by a suspension spring, or by being partially balanced, and this increases the sensibility of the lamp, since it causes it to respond immediately to any sudden lengthening of the arc by the bodily movement of the gearing frame and train.

It is obvious, in order to make the efficiency of an arc lamp as high as possible, that care should be taken, first, that the resistance introduced into the main circuit be as small as possible, and secondly, that the smallest possible amount of energy be allowed to flow through the shunt or by-pass circuit. The resistance of this latter, then, should be as great as possible, and by the employment of the reciprocal armature, the author has been able to raise this resistance to 2,000 ohms. On account of the resistance of the shunt, or by-pass being so great, it is almost impossible to burn it, especially if the generating plant be provided with suitable regu-

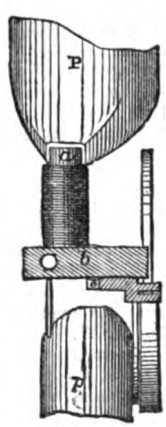

FIG. 5.

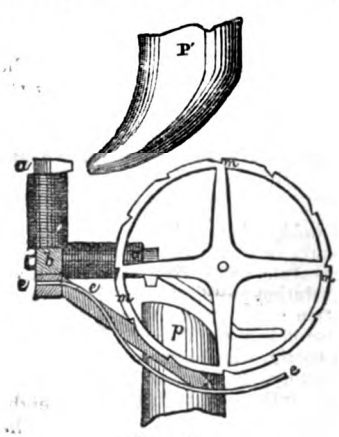

FIG. 6.

lating appliances. The burning of the shunts of differential lamps has hitherto been a source of some trouble.

A peculiarity of this lamp consists in the fact that it will continue to feed even though the shunt be burned. In order that it may do this, a little lever is generally attached to the cross-bar *b*, *b* (Figs. 2, 3, 4, and 5) of the reciprocal armature, and projects in the opposite direction to the brake spring *e*, *e*, *e*. Projecting from the rigid frame of the lamp is a stop, so placed in relation to this lever, that when the gearing frame *n*, *n*, *n*, *n* descends, it engages with the lever and thus removes the brake. The action of the lamp after the burning of the shunt is easily seen. The gearing frame, when a normal strength of current is flowing, is held up against the top of the rigid frame. As, however, the

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length of the arc becomes greater, and its resistance in consequence increases, the gearing frame slowly descends, and after a time the lever engages with the stop, and the break being thereby removed, the mechanism feeds, but ceases to do so as the strength of current increases, and the gearing frame gradually rises. The rack instead of being solid is formed of a drawn brass tube, and the arbors and the fulcrum of the reciprocal armature instead of being supported in bearings are carried upon hardened steel points. The employment of the latter greatly increases the life of the motion.

(TO BE CONTINUED.)

PHYSICAL SOCIETY.—Nov. 22.

The President (Professor Guthrie) in the chair.

Mr. James Bewsher was elected a member of the society.

The following notes were read by Mr. R. T. GLAZEBROOK, M.A., F.R.S., 'On the Permanence of some Standards of Electrical Resistance." The author has had occasion to compare with ten standard B.-A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 9·98335 B.-A.-U. at 14°05C., while Lord Rayleigh found the value 9·98330 B.-A.-U. Thus either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent. "On the Effect of Moisture in Modifying the Refraction of Plane Polarised Light by Glass." The author described some experiments he had been engaged in lately at the Cavendish Laboratory. Plane polarised light is made to fall on a plate or a wedge of glass at various angles, and the position of the plane of polarisation determined. It is found that this depends greatly on the hygrometric condition of the air in the neighbourhood of the glass. If moist air be blown on to perfectly clean glass the plane of polarisation of the emergent light is displaced from its normal position in one direction, while if dry air be blown it is displaced in the opposite direction. At an angle of incidence of 60° the difference between the two positions is from 6′ to 8′. If, however, the glass be not perfectly clean, the effect of moisture is *at first* the same as that of dry air, though on stopping the draught an opposite effect is observed. The author assigns as the cause of this the heating of the surface, which, as Magnus discovered, is produced by a draught of moist air. He finds, on repeating Magnus's experiment, that the heating is not produced if the glass be clean, and he shows by an independent experiment that slight local heating does produce an effect on the plane of polarisation in the same direction as that due to the dry air.

Mr. Glazebrook also exhibited a spectrophotometer, described by him in a paper read before the Cambridge Philosophical Society (*Proc. Phil. Soc.*, Vol. IV., part 6), and made by the Cambridge Scientific Instrument Company from his design.

A note "On a Point in the Theory of Pendent Drops," by Mr. A. M. Worthington, was read by the SECRETARY (Mr. Walter Baily). This was a note upon a paper recently communicated by the author to the Royal Society upon the measurement of the surface tension of a liquid from observations of the forms assumed by pendent drops. By making a measurement of a horizontal section of such a drop, and of the angle made by the tangent plane to the surface at the line where the section meets the surface, with the horizontal, and knowing the density of the liquid, sufficient data are obtained to determine its surface tension.

Professor PERRY, remarking upon this paper, gave an account of some researches upon the subject, in which, some years since, he had assisted Sir William Thomson. On the usually accepted theory of "surface-tension" based upon the behaviour of liquids in capillary tubes, at every point of the surface of a liquid the equation

$$kp = \frac{1}{R} + \frac{1}{R'}$$

must hold, where p is the pressure at that point or the difference of pressures on the two sides of the surface, R and R′ the two principal radii of curvature, and k a constant. In the case of a drop whose surface is one of revolution about the vertical, the contour may be drawn from the equation; this was done, and the theoretical drawings were made of a number of drops. These have since been compared by Sir W. Thomson with enlarged photographs of actual drops, and the results are highly satisfactory. This law no longer holds in the case of a drop at its "critical point," or that point when it is about to fall, since here dynamical action comes in.

Mr. BAILY also read a paper by the same author "On a New Capillary Multiplier." This is an apparatus for the measurement of surface tension, and is a modification of one used by M. Despretz. From one extremity of the arm of a balance is suspended a roll of platinum foil, consisting of a strip 50 centimetres long and five or six centimetres broad rolled up, the successive convolutions being prevented from touching by rolling up with the foil a number of small pieces of hard glass tubing about two millimetres diameter which occupy the upper part of the helix, and preserve the form of the lower part. The coil is cleaned by igniting it in a Bunsen flame, and then suspending it with its lower end in the liquid to be examined. The increase in weight corrected for the part of the coil immersed is due to the fluid rising between the convolutions. From this the surface tension is readily calculated.

Mr. HILGER described a new solar eye piece. In Professor Pickering's eye piece there are two rectangular prisms of glass of slightly different refractive indices. The light of the sun undergoes partial reflection at the surface separating the two prisms, the ratio of the reflected to the incident light diminishing with the difference between the refractive indices. It is found, however, that such a prism under a high power always gives a double image due to the two glass surfaces, it being practically impossible even under enormous pressure to bring them into true contact. To obviate this Mr. Hilger makes the second prism of Canada balsam, which gives the most satisfactory results, the image being pure and single.

LEGAL.

Edwards v. Dennis, re "Neptune" Brand.

This action recently came on for trial at the Liverpool Assizes before Mr. Justice Smith and a special jury. Mr. Charles Russell, Q.C., Mr. French, and Mr. Lawrence, instructed by Messrs. Whitby, Maddock and Co., of Liverpool, appeared for the plaintiff; and Mr. Henn Collins, Q.C., and Mr. Cutler, instructed by Messrs. Van Sandau and Co., of London, appeared for the defendants. At an early stage of the trial it was agreed to discharge the jury, and to leave all matters of fact and law to the judge. This action (which involves very important questions of trade and law) was brought by Mr. Edwards, of Birkenhead, to restrain Mr. W. F. Dennis, the London representative of Messrs. Felten and Guilleaume, of Mulheim-Cologne, Germany, manufacturers of wire, from using the Neptune brand. The facts are shortly as follow:—In the latter part of 1878 Messrs. Cromar, Scott and Co., of Liverpool, manufacturers of iron sheets and jobbing galvanisers, registered as a trade mark in Class 5 a device consisting of the figure of the god Neptune, with the word "Neptune." About 18 months since Mr. Edwards acquired the business of Cromar, Scott and Co., including the trade mark in question. In 1880 Messrs. Felten and Guilleaume registered for steel wire and iron wire (Class 5) a trade mark, consisting of a Trident and the word "Neptune." It was elicited on cross-examination of the plaintiff and his witnesses that neither he nor Messrs. Cromar, Scott, and Co. had ever manufactured wire, but that over a period of ten years Messrs. Cromar, Scott, and Co. had galvanised small lots of wire of other manufacturers, the entire quantity of wire so galvanised not exceeding five to ten tons, and that they had not galvanised any wire for the last five years, and that Mr. Edwards for several years had been cognisant of the defendants' brand.

On behalf of the defendant evidence was given to show the enormous quantity of wire manufactured by Messrs. Felten and Guilleaume from the year 1877, and which had been advertised and sold by them under their Neptune brand.

The further consideration of the action stands over until the return of Mr. Justice Smith to London, when the important question of law will have to be argued before him.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. NOV. 27.		BUSINESS DONE WEEK ENDING NOV. 27. Highest.	Lowest.
Anglo-American	34,	35	35	33
Do. Preferred	59,	60	60½	57½
Do. Deferred	9,	10	9⅞	8⅞
Brazilian Submarine	10⅞,	11⅛	11⅛	10⅞
Cuba	11,	11½	11½	—
Do. Preference	17,	18	—	—
Direct Spanish	3½,	4	—	—
Do. Preference	13,	15½	—	—
Direct United States Cable	10,	10½	10⅜	10½
Eastern Telegraph	11½,	11⅞	11⅞	11⅞
Do. 6 per Cent. Preference	13⅜,	13⅝	13⅞	13⅜
Do. 5 per Cent. Debentures, 1899	104,	107	105½	—
Eastern Extension	12,	12⅛	12⅛	11 15-16
German Union	9⅛,	10⅛	—	—
Globe Telegraph and Trust	7⅛,	7⅜	7 5-16	7⅛
Do. Preference	12½,	12⅝	12⅝	12 7-16
Great Northern	14⅜,	14⅝	14⅝	14½
Indo-European	32,	33	32½	—
Reuter's	7½,	8	—	—
Submarine	175,	180	177	—
West India and Panama	⅞,	1⅛	15-16	⅞
Do. 1st Preference	7½,	7⅞	—	—
Western Brazilian	7,	7½	7⅛	6⅞
Western Union 7 per Cent. 1st Mortgage	120,	122	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	101	—

TELEPHONES.

Consolid. Telephone and Maintenance	5-16,	7-16	—	—
Oriental	⅛,	⅜	—	—
United Telephone	12,	12½	13	10½

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1½,	1½	1⅝	1½
Do. (fully paid)	3,	3½	3½	—
Hammond Light (£3 15s. paid)	¾,	1	1	¾
Swan	—	—	1-16	—
Maxim-Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	34,	35	35	34⅜
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	23½	22½

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NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 28th Nov. amounted to £3,872.

EARTHQUAKE SHOCKS AT GENEVA.—Several violent shocks of earthquake were felt at Geneva shortly after 11 o'clock on the night of the 27th ult.

LIGHTING OF THE MANSION HOUSE.—The Hammond Company has obtained the contract for the electrical lighting of the Mansion House, London.

THE "GREAT EASTERN."—This steamship, before she sails for the New Orleans Exhibition, is to be fitted up throughout with incandescent electric lamps.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts for the month of November were £1,736 against £1,781 in the corresponding period of last year.

THE EASTERN TELEGRAPH COMPANY.—The Eastern Telegraph Company's traffic receipts for the month of November, 1884, amounted to £55,640, and to £49,390 in the corresponding period of 1883.

HEALTH EXHIBITION AWARDS.—Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, E.C., have been awarded a gold medal by the Jury Commission of the Health Exhibition for incandescent lamps.

TELEGRAPH OPERATORS IN GERMANY.—While, in the Fatherland, lady operators are content with £4 a month, men refuse to accept such a low salary, especially as they have to be at their posts many hours in the day.

NEW TELEGRAPH OFFICE.—The name Santiago (Cape de Verde Islands) should be added to the list of telegraph offices. Telegrams can be sent to Santiago by the Eastern, the Direct Spanish, and the Submarine Telegraph Companies.

ELECTRIC LIGHT AT VIENNA.—The offices and printing rooms of the *Neues Tageblatt* of Vienna are lighted by 300 Edison incandescent lamps fed by an Edison dynamo. The lamps in the offices are movable, with supple leads.

ELECTRIC LIGHT IN PICTURE GALLERIES.—The central hall of the Corporation Galleries of Glasgow, which at present contains the valuable collection of paintings lent by the Marquis of Bute, is now illuminated with electric light.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ended 28th Nov., 1884, were £2,436, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

INDIA RUBBER STAMPS.—We have received from Mr. E. Ellison, of 41, Glover-street, Leeds, catalogues and samples of his improved rubber type and stamps, which, for both office and domestic uses, are rapidly becoming almost indispensable.

ELECTRIC LIGHT IN CHELSEA.—The Chelsea Electricity Supply Company notify their intention of applying to the Board of Trade for a Provisional Order enabling them to produce, store, and supply electricity within the parish of Chelsea.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts for November amounted to £22,800; from 1st January to 30th November they amounted to £257,480; and in the corresponding months of 1882 and 1883 to £223,863 and £236,469 respectively.

EASTERN EXTENSION AUSTRALASIAN AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company, including subsidies, for the month of November, 1884, amounted to £42,286, and to £36,719 in the corresponding period of 1883; increase, £5,567.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 30th Nov. are £2,333, as compared with £2,340 in the corresponding period of 1883. The August receipts, estimated at £4,835, realised £4,909.

ELECTRIC LIGHT IN FRANCE.—Edison lamps have lately been installed at the following works in France:—50 at Toffin's lace manufactory, Caudry; 40 at Chaffrée's foundry, Le Mans; 50 and 8 regulators at Cointraux' distillery, Angers; and 25 at Lorthillois' Spinning Mills, Tourcoing.

ELECTRIC LIGHT AT MADRID.—Gas is dear in the Spanish capital because of the high rates of carriage for coal and the want of market for the sub-products of the gas works. There is a movement for establishing a central station with two alternate-current Gordon dynamos supplying 12,000 lamps.

SIMULTANEOUS TELEGRAPHY AND TELEPHONY.—The inventor of this system, now being applied throughout Belgium, M. Van Rysselbergh, director of the Brussels Observatory, has been appointed consulting electrician to the Department of Railways, Posts, and Telegraphs, and also made chevalier of the Order of Leopold.

A NEW LAMP.—An incandescent electric lamp has been invented by Mr. James W. Benson, of North Adams, Mass. It is constructed with a spring pawl attached to the globe cap and engaging with ratchet teeth formed upon the outer surface of the insulating ring, so the globe will be locked against accidental displacement.

INDUCTION AT TEMESVAR.—Besides the difficulties recorded last week, the leads for the electric light at this Hungarian town were found to exert an injurious influence on the telephone conductors, so that the two companies agreed to alter the course of the wires in several places. Still, we learn the evil is only partially remedied.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of November was 2,745, estimated to produce £2,475, against 2,866 messages, producing £2,580 in the corresponding month of last year. The traffic receipts for the month of August, estimated at £2,375, realised £2,515.

COMPAGNIE INTERNATIONALE DES TELEPHONES.—As a sufficient number of shareholders to constitute a legal assembly did not attend the special general meeting called for the 29th Nov., notice is given of another special meeting, to be held on 18th Dec., at 24, Rue des Douze Apôtres, Brussels. The chief business is the reduction of the nominal capital.

AWARDS AT TURIN.—In addition to the ordinary medals awarded by the jury of the Turin Exhibition, four gold medals of higher value have been placed at their disposal by the Italian Minister of Public Instruction. One has been given to Professor Ragona, director of the Modena Observatory, for the electrical instruments invented and exhibited by him.

ELECTRIC SEARCH LIGHTS BEFORE SUAKIM.—Our Paris contemporary *L'Electricité*, which often gives a view of some application of the electric light, gave last week a representation of the powerful search light on board one of H.M. ships,

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which rendered great service in repelling night attacks, in avoiding shoals, and in aiding the gunners to direct their fire.

PNEUMATIC TELEGRAMS IN PARIS.—The telegraph service within the Paris fortifications will be performed entirely by pneumatic tubes from 15th inst. Messages must be written on stamped forms, at the following prices:—Card-telegram, 30c. (3d.); ditto with answer prepaid, 60c. (6d.); closed telegram of any number of words, 50c. (5d.); ditto with reply prepaid, 1f. (10d.).

THE TELEGRAPH IN HUNGARY.—It appears from the returns of the Minister of Communications that the length of telegraph lines in Hungary at the end of last year was 16,223 kilometres (10,080 miles), the wire measuring 59,149 kilometres (36,754 miles). There were 542 State telegraph offices and 706 belonging to railway companies. The persons employed numbered 1,442 men and 223 women.

ELECTRIC LIGHT IN AUSTRIA.—It is reported that the Oesterreichische Nordwestbahn is about to adopt the electric light at Königsgrätz Station, which is 1,100 metres (3,280ft.) long. The cost of installing twelve 1,000 candle arc lamps is estimated at 24,000 florins (£2,400); and the expense of maintenance at 5,800 florins (£580) yearly, while a hundred paraffin lamps giving a light of 2,400 candles cost 6,500 florins (£650).

INVENTORS' INSTITUTE AND THE PATENT ACT.—The meeting on Monday next, 8th inst., will be devoted to the discussion of the Patent Act of 1883, section by section, commencing with Part I., Section I., the chair being taken at 8 p.m. by Vice-President Admiral Selwyn. The discussion will be continued on 12th Jan., 1885. Gentlemen, not being members, who wish to attend should apply to the Secretary, Inventors' Institute, Lonsdale-chambers, Chancery-lane, W.C.

WEATHER FORECASTS BY TELEPHONE.—*Le Franklin* says that, by observing and comparing the sounds emitted by a telephone connected by leads with two iron bars, stuck into the ground a few metres apart, it is possible to have an indication of the coming weather, sometimes ten to twenty hours in advance. In the case of a thunderstorm, especially, a noise like that of shrivelling leaves increases until a flash of lightning occurs, when it resembles that of rain or hail falling on glass.

CATALOGUE.—We have received the monthly price list of new machinery issued by Duncan Brothers, engineers, 32, Queen Victoria-street, E.C.; it is now illustrated by permanent carbon photos. This firm recommends the use of the "A B C Telegraphic Code Book" to firms ordering in a hurry by cable. By permission of the publishers, they give a table of code words for several banks, and selected phrases applicable to the list, as well as a code word for each of their specialities.

ELECTRIC LIGHT IN CARRIAGES.—This application of electric light, which has frequently been seen in Paris lately, has now been imported into England, as we read that a private one-horse brougham, well equipped, drove along one of the principal thoroughfares in London on Wednesday evening, lighted throughout by means of electricity. A brilliant star shone on the horse's forehead, another on the coachman's hat, and a third at the back of the carriage. If we mistake not these are Trouvé's lamps, recently noticed in this journal.

UNIT OF ELECTRICAL RESISTANCE.—For the time being, as decided by the International Congress of Electricians, which met at Paris on 3rd May last, the ohm, or unit of electrical resistance, is the resistance of a column of mercury 1 square mm. in sectional area and 106 centimetres long, at the temperature of melting ice. M. Jamin has brought to the notice of the Paris Academy of Science an instrument, devised by M. René Benoît at the instance of the Minister of Posts and Telegraphs, for giving the exact dimensions of the tube containing the column of mercury.

PARIS ELECTRICAL EXHIBITION, 1885.—By way of completing the note in last issue, this exhibition will be held at the Paris Observatory in a series of rooms which the director, Admiral Mouchez, has placed at the disposal of the Société Internationale des Electriciens. French and foreign electricians, whether members of the society or not, are invited to exhibit; and there will be no expense beyond the carriage and arrangement of articles sent. Applications for space must be made by 25th inst. to the President of the Société Internationale des Electriciens, 3, Rue Séguier, Paris.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—The annual general meeting for the election of council and officers for 1885 will be held at the Institution of Civil Engineers on Thursday, December 11, when a paper will be read on "Electricity in America," by W. H. Preece, F.R.S., Past President. The new officers for election at the next meeting are:—President, C. E. Spagnoletti, M. Inst., C.E. Members of Council: Major R. Y. Armstrong, R.E., Professor George Forbes, F.R.S.E., and Joseph W. Swan. Associate Members of Council: Lieut-Colonel A. C. Hamilton, R.E., O. E. Woodhouse, and Alexander Pelham Trotter.

FOLLY, OR GLORY?—In the telegram containing the text of Lord Wolseley's address to the troops, Colonel Stewart's ill-fated enterprise is spoken of as one of "unusual danger and folly." Obviously there is some mistake here; and the *Pall Mall* suggests that "peril" is probably meant, as it might "easily be read for 'folly' in Morse code." Our contemporary is misinformed. These two words have not the remotest likeness in Morse code, besides constituting a tautology not likely to be committed by Lord Wolseley. We suspect that the error is one of sound, in which case "glory" would be the most probable correction. Even in Morse code "glory" is much more like "folly" than "peril."

RAPID INSTALLATION.—The ease and celerity with which temporary installations of electric light can be made has just been exemplified by Messrs. Woodhouse and Rawson, who recently lighted up Lady Filmer's residence at Maidenhead, utilising Colonel Fremantle's dynamo and engine, a quarter of a mile distant. The work was only commenced at about eleven o'clock on the preceding morning; but the whole of the cable was run and the lamps were fitted up in time for the dance without any hitch, the lighting being perfectly steady during the whole evening. People having their houses permanently lighted by electricity can thus, by lending their currents on occasion, confer a considerable benefit upon their friends, as the electric light, owing to the absence of heat, greatly enhances the comfort of the guests at a dance, besides adding brilliancy to the decorations.

PARIS EXHIBITION, 1889.—The President of the French Republic has issued a decree that a universal and international exhibition of industrial products shall be held in Paris from 5th May to 31st October, 1889. A second decree appoints a commission of thirty-three members for carrying the scheme into effect, with M. Antonin Proust as president, and M. Tesserenc de Bort and M. Eugène Spuller as vice-presidents, the other members being high functionaries and the presidents of

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large syndical associations. A project has been submitted to the commission for including in the area of the exhibition, not only the Champ de Mars and the Trocadero, but also the Esplanade des Invalides and the Palais de l'Industrie, giving a space of 400,000 square metres (4,305,720 square feet) more than in 1878. It is said that Germany will not only participate, but has also used its good offices to secure the participation of other countries.

THE CREIL EXPERIMENTS.—It has been decided to use a cable, with core of silicious bronze, supplied by M. Lazare Weiller, manufactured under the Berthoud and Borel patents, of which the Kinetic Engineering Company are the sole licensees in England. An order has been given for 78,000 metres (49 miles) of this cable to be delivered as soon as possible. It is calculated to carry a current of 20 amperes with an E.M.F. of 7,500 volts, equal to 150,000 watts or 200 horse-power. We learn from the *Bulletin* of the Cie Internationale des Téléphones that testing some of the machines has shown the necessity for modifying the collectors, which did not answer their purpose with the currents of high tension employed. The weight of steel and cast iron in each receiver is about 4 tons, independently of the coil; and M. Marcel Deprez has found that the friction of the shaft alone, running light, absorbs 20 horse-power.

IMITATION OF ELECTRICAL PHENOMENA.—In an article in the *Journal de Physique* on "Imitation by Liquid or Gaseous Currents of Electrical and Magnetic Phenomena," M. C. Decharme, after passing in review the mechanical, physical, chemical, and physiological effects of these currents, comes to the following conclusion:—After having initiated, by means of liquid or gaseous currents, in numerous experiments, the principal phenomena of static or dynamic electricity of electro-chemistry, and even of electro-physiology, I feel justified, from analogy of the effects, in believing the analogy of the causes; for instance, that the electrical (or magnetic) phenomena are assimilable to hydro-dynamical phenomena; that is to say, electricity, under the form of current (of ether or of ponderable matter) is analogous to a liquid current, and, in the state of tension, is analogous to a certain quantity of liquid issuing in the form of a jet.

TECHNICAL HANDBOOKS.—Messrs. Symons and Company, of Bouverie-street, E.C., are bringing out some new hand-books for students and practical engineers, called "The Specialist's Series," edited by Dr. Paget Higgs and Professor Charles Forbes. It is intended to impart information on recent technical subjects, in a manner suited to the average intelligence, and in language "to be understanded of the common people." Each volume is to be written, as far as possible, by an independent author, "unflavoured with the taint of commercial advocacy," and giving the results of practical experience. Vol. 1, on Dynamo and Magneto-Electric Machines, by Paget Higgs, LL.D., D.Sc., is now ready, and contains observations on electrical storage, so far as it may be considered as an auxiliary in regulating the current of dynamo-electric and magneto-electric machines. Other volumes on gas engines, ballooning, primary batteries, and arc and incandescent lamps will shortly be issued.

ELECTRIC LIGHT IN MILLS.—The *Journal of the Society of Dyers and Colourists* says:—"It is interesting to know that the electric light is gradually being introduced into the mills and dye-houses in Bradford. At the wool scouring works, where the men have to work all night, the light is greatly appreciated, not only on account of the better light which they have to work by, but also because the air is so much cooler and purer than when gas is burning. In the dye-houses the arc light is used chiefly for 'matching shades,' and is, as a rule, very reliable, especially if none but good carbons be used, as a bad carbon causes sputtering and flickering which makes the light change from a white to a violet tone, and *vice versâ*, and so gives a wrong impression of shade to the dyer. The incandescent lamp is not much used for matching shades, as the light is too yellow, but it is very useful in grey rooms, cleaning rooms, &c., where benzine is used, and in any place where there is much danger of fire."

TELEPHONE DEVELOPMENT.—On Tuesday afternoon, the Postmaster-General received in the Conference Room of the House of Commons a deputation consisting of Sir Massey Lopes, M.P.; Mr. Macliver, M.P.; Mr. Puleston, M.P.; and Mr. Clarke, Q.C., M.P., on the above subject. Memorials were presented on behalf of the Port of Plymouth Incorporated Chambers of Commerce, the Plymouth Mercantile Association, and the Devonport Mercantile Association. The memorialists comprised merchants and traders carrying on business in Plymouth, Stonehouse, and Devonport, and it was pointed out that the present exchange at Plymouth had only forty-two subscribers, and was therefore of little or no use to them. They desired that Stonehouse and Devonport, with Plymouth, should be considered one town for telephonic purposes. The Postmaster-General replied that he had no doubt the department would send some one to the places mentioned to make inquiries, and that he would give the matter due attention.

SCIENCE AND RELIGION.—A company is at present fixing a number of microphones in Dr. Talmage's Tabernacle, Brooklyn. They are to be connected by wire with the houses of certain members of his flock, who will thus be enabled to hear the discourses of the great "pounder and expounder," as an American journal calls him, when circumstances prevent them from being personally present among the congregation. Dr. Talmage possesses a voice of uncommon power, and it has been calculated that with the aid of a sufficient supply of microphones he would be quite capable of filling the Brooklyn Academy of Music, Plymouth Church, Madison-square Gardens, and three other auditoriums, in addition to his own tabernacle. One of the promoters of the undertaking thinks it is destined to inaugurate a revolution in the "preaching trade." Every other trade, he says, has to compete with machinery, and all skilled labour has thereby advanced; "while religion has stood under the old rule of one minister to one church." The time is near at hand, he predicts, when twelve clergymen to each denomination "will cover Brooklyn thoroughly;" and when Dr. Talmage, in particular, will be preaching to twenty congregations every Sunday.

NEW YORK.—The first experiment with electricity as a motive power on the elevated railroads will be made on the Second Avenue line. A central rail twenty pounds heavier than those now in use will be laid between the rails from Chatham-square to the Harlem River terminus. Current will be conducted from the dynamos to the central rail by a large wire. The rail will be insulated, but the present track will remain as at present. All the electric railway companies will be allowed equal facilities for experiments with the motors, and the expense of laying the third rail will be divided between them. A commission to be selected by the companies will decide on the relative merits of the inventions. The regulation of the speed of trains, it is said, will be less difficult with electricity than with steam. Trains can be stopped more quickly, and at all

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times will be under more perfect control. They will be run with increased safety and less noise, while smoke and cinders will be avoided altogether. The cost of working the roads will be greatly reduced by the use of electricity if the experiments should be successful. Representatives of the electric railway companies say that it will not take more than two months to prepare for the proposed test on the Second Avenue line.

THE ORIENTAL TELEPHONE COMPANY.—An extraordinary general meeting of this company, convened by requisition of the shareholders, is to be held at noon on 22nd inst., at Cannon-street Hotel, with the following objects, viz. :—(1.) To consider the propriety of appointing, and if thought desirable, to appoint a committee of investigation, to examine into the affairs of the company, with power to inquire into and report upon all agreements effected with subsidiary and other companies. (2.) To increase the number of directors by appointing five additional directors or any less number, such increase not to involve any increase of the directors' remuneration. To meet this action on the part of the shareholders the directors propose to submit the following resolution :—"That Clause 58 of the company's Articles of Association be repealed, and that in lieu thereof the following shall henceforth stand and be Article 58," that is to say, "The remuneration of the directors shall be £500 per annum, and in any year in which an annual dividend of over 5 per cent. per annum is paid upon the amount of the capital, for the time being paid up, or deemed and taken as paid up and entitled to dividend, an additional sum of £250 for every one per cent. per annum of dividend paid over and above said dividend of 5 per cent. ; provided always that in no event shall the remuneration of the directors exceed the sum of £2,500 per annum. The remuneration shall be divisible among the directors as they shall determine."

THE GULCHER COMPANY.—This company has lately installed twenty-four 800-candle and two 2,000-candle arc lamps, supplied by a No. 5 dynamo, for Messrs. A. Ransome and Co., of Chelsea ; and ten 800-candle and six 2,000-candle arc lamps, supplied by a No. 4 machine, in the foundry of Messrs. Ransome, Josselyn, and Woods, of Battersea. The gas has been entirely superseded in the large erecting shop (180ft. long by 40ft. wide) of the Coalbrookdale Company, by one 3,000-candle and two 1,000-candle arc lamps, supplied by a No. 1 dynamo ; and although the latter is driven by the same engine as the shafting, the power absorbed by which is not at all constant, the light is remarkably regular. The Gülcher Company has added to the electric lighting plant of the Patent Shaft and Axletree Company, Wednesbury, which now consists of five 3,000-candle and six 2,000-candle arc lamps supplied by a No. 4 dynamo. The same company is lighting a pit mouth of the Tir Pentwys Colliery Company in Wales with a 3,000-candle arc light, which has taken the place of large fires consuming from 10 to 15 cwt. of coal nightly, while the offices are lighted by incandescent lamps, all being supplied by a No. 1 compound-wound dynamo. The rag-sorting department of Messrs. E. Fox and Sons' paper mills at Dewsbury is lighted by thirty-two 20 candle incandescent lamps, supplied by a No. 1 dynamo, while the yard is illuminated by an arc light. The Gülcher Company has also been instructed to light with incandescent lamps the saw mill of Messrs. J. and C. S. Young, of Salisbury, who have ample power and anticipate a great saving of expense.

DEATH AT THE WIRE.—Two cases of telegraph operators dying at their posts have lately been reported from America in the unsentimental phraseology peculiar to Transatlantic journalism. "Ned" Cummins, employed in an office in Virginia, was engaged in "receiving" a press report when he signalled to the operator at the other end : "Been spitting blood, take it easy." Directly afterwards the poor fellow dropped from his chair dead, but—if it be not brutal to say so—there was no great delay to the press report, for very shortly afterwards another hand was secured, who wired to the "sending" clerk these words :—"Cummins just died ; I'm his substitute ; go ahead after 'address,'" this being the last word written by Cummins when the grim ferryman beckoned him. The other case was of one Monk Monroe, who finding himself in the middle of his work stricken by the "blindness of death," had just time to signal along the wire, "Send a doctor, I am going up the hill," and he was "relieved" for ever. He was found with his hand upon the "key." We believe that this evil is a growing one, especially as three cases of insanity are reported by a Scotch contemporary to have occurred at the Edinburgh office only this year. We also believe that it arises chiefly from the concentration of the mind necessary in taking down by sound. Human beings are capable of concentrated effort for a certain length of time, but cannot, like machines, or Tennyson's brook, "go on for ever." The remedy is to be found in reasonable hours, change of occupation, and one good holiday in a year to recharge the human battery.

ELECTRICITY AND DENTISTRY.—Electricity has become such a useful aid to the dentist, chiefly in America, where the chief applications have been invented, that many leading practitioners now regard it as indispensable. The electric mallet, invented by Dr. Bonwill, has now been in use about ten years, and it has lately been improved by Dr. Webb. It is actuated by a special four-cell battery exactly adapted to the power required, and has the great advantage that the blow is delivered upon the packing instrument (for stopping teeth) just at the point where its force is greatest, because the attraction of the magnets constantly increases, as the mallet approaches them, until the circuit is broken. An electric dental engine, for drilling, filing, and polishing teeth to be stopped, has lately come into use, driven by the Electro-Dynamic Company's double-induction electric-motor and automatic battery. It is stated that, with sufficient battery current, the motor is so powerful as to be able to lift two thousand times its own weight one foot per minute, and that the drill may be rotated at 10,000 revolutions per minute. The battery consists of six 1-gallon cells with two carbons and one zinc in each, and an automatic device for removing the electrodes from the fluid when not in use. A switch-board is provided for those who run the drill and the mallet with the same battery. But what will probably be found the electrical invention of the greatest use to dentists is the mouth lamp and mirror. This consists of a small incandescent lamp, fixed in a resistance handle for regulating the current, and fitted with a non-conducting shield, which prevents the radiation of heat, and directs the light to any point desired. The lamp throws such a strong light on the teeth as to render them transparent, when the slightest speck of decay may be at once detected. To develop the full capacity of the lamps requires from 3½ to 4½ volts, that is to say, the current of two to three cells of a Bunsen, or three or four cells of a bichromate battery. A modification of this instrument also serves as a laryngoscope.

EDWARD DAVY AND THE TELEGRAPH.—The following communication as to Mr. Edward Davy's claim to the invention of the electric telegraph has been sent to the Agent-General for

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Australia by the Premier of the Colony:—"Premier's Office, Melbourne, Sept. 8, 1884.—Sir: I had the honour of receiving, on the 27th August, a deputation from the Royal Society of Victoria, bringing under my notice the claims of Mr. Edward Davy, M.R.C.S., as one of the earliest inventors of the method of using dynamic electricity for telegraphic purposes. From the representations of the gentlemen forming the deputation, it would seem that, though Mr. Davy's claims have for very many years escaped recognition, he is genuinely entitled to the gratitude and consideration of the civilised world. Mr. Davy's claims being thus of world-wide bearing, I at first thought that it might seem presumptuous in me to take the lead in acknowledging them, but it was represented that the fact of Mr. Davy's being domiciled in Victoria gave us a title to move in the matter, and I therefore consented to place the sum of £100 on the estimates for this year, merely as an initiatory step in recognition of his services. The deputation also requested me to assist them in an application to the Imperial Government to get Mr. Davy's name placed on the civil list. I pointed out that an application under this head would come with greater force from scientific bodies, and the deputation accepted my suggestion to move in this respect through the Royal Society of London. I promised, however, to communicate with you, and request you to support in every way in which you can the recognition of Mr. Davy, and this I now beg to do. I enclose for your information a few copies of a printed statement which were left with me by the deputation, and a newspaper cutting, and would refer you for fuller information to articles by Mr. J. J. Fahie and Mr. H. Davy, in *The Electrician*, Vol. XI., 1883. Each of these articles has been issued in the form of a separate pamphlet from the office of *The Electrician*. I feel sure that the matter is one which will gain your interest and attention.—I am, &c., JAS. SERVICE. R. Murray Smith, Esq., Agent-General, London."

REPULSION BETWEEN MAGNETIC LINES OF FORCE.—The following letter, by Mr. R. H. M. Bosanquet, appears in the current number of the *Phil. Mag.*:—The idea of a repulsion between magnetic lines of force was derived by Faraday from the repulsion which exists between two magnetic needles placed "side by side with like poles in the same direction" ("Exp. Res." Vol. III., p. 419). In the deduction of the forces which accompany lines of force, Maxwell reduces them to a tension along the lines of force, combined with a pressure in all directions at right angles to them. Now it is easy to show experimentally, and indeed it is well known, that rings magnetised by means of a continuous coil uniformly wound round them present no external magnetic action, though they may be the seat of closed circuits of magnetic lines of force of very great intensity. It is clear that in this case we may suppose the ring divided into a number of separate rings, each containing lines of force, and that such rings will be wholly without action on one another. If, then, such similar rings be placed parallel and close to each other, they do not repel each other, as they should do if there existed a repulsion between parallel lines of force. Practically, it is impossible to obtain rings so uniformly forged and wound as to be entirely without external magnetic action. This usually manifests itself as a slight polarity, which is easily recognised by a compass-needle, the poles being at the extremities of a diameter. But in my rings this polarity has always been small, even when the induction in the ring was 10,000 or thereabouts. I have suspended two such rings parallel to each other by strings, and made the contacts by the ends of the coils dipping into mercury. But neither by reversing the magnetism of the rings relatively to each other, nor by make or break have I ever been able to cause the smallest movement of the nature of approach or recess of the rings with reference to each other; and this was only to be expected from what is well known. We may notice that, in the illustration of Faraday, the movement of the system of two parallel needles due to their repulsion leads to a redistribution of the lines of force. It appears, therefore, that the repulsion here observed must depend upon this redistribution. To illustrate what is meant, suppose the lines of force to exert their tension like elastic bands on a mechanical system such that, when yielding to the tension takes place, the needles are separated. In this case, whenever the lines of force are prevented from changing their form, the repulsion at right angles to them must disappear; and this appears to be what actually happens.

ADVANTAGES OF COMPOUND DYNAMOS.—With reference to the arguments against compound dynamos, put forth by the *Zeitschrift für Elektrotechnik*, and reproduced in *The Electrician* of 29th November, Herr Uppenborn says that they only have the appearance of being warranted. Thus, it is neither necessary nor possible to attain constancy within 1 per cent. In practice, incandescent lamps constructed for a difference of potential of 100 volts require tensions differing 5 per cent. for being raised to the same temperature. The manufacture of these lamps has not yet attained so high a degree of perfection that such precision may be relied upon. The manufacturer does not employ the same measuring instruments as the engineer charged with the installation, and differences of 4 and 5 per cent. may readily be admitted. Besides, laboratory instruments could not well be put into the hands of a workman. Nor is it true that a compound, for an increase of intensity of 20 per cent. manifests a difference of potential of 3 per cent. A Schuckert machine only shows a variation of 3 per cent., the intensity varying from zero to the maximum. If so satisfactory a result cannot be attained generally, it is at least possible to approach it very nearly. The heating of the machine is not of great importance. Let it be so with a compound, of which the induced has a resistance of 0·31 ohm up to 28 amperes. The resistance of copper increases 0·4 per cent. for every centigrade degree. Let a deviation of temperature be supposed of 20°C., which corresponds with an increased resistance of 8 per cent., or 0·025 ohm. The product of the maximum intensity, 28 amperes by 0·25 ohm, gives 0·7 volt. The inductors of the compounds are, besides, so constructed as to have slight resistance and to heat very little, so that the influence of heating is infinitesimal. A shunt dynamo, *cæteris paribus*, cannot present the same constancy as a compound; and the statement that the difference of potential at the terminals of an Edison dynamo is only 1 per cent. for an increased intensity of 50 per cent. must be taken *cum grano salis*. But supposing this strictly true, it only proves that the dimensions of an Edison machine are quite abnormal. The inductors are excessively large with respect to the induced, especially in the original American type. The machines which gave the diagrams instanced are, on the other hand, almost of the same dimensions, and it is rational to compare them. Now, in this case, the maximum production of the intensity by the difference of potential at the terminals is obtained when R = 26 ohms, and from 30 to 40 ohms the tension increases about 25 per cent. This shows conclusively that it is more advantageous to construct a compound dynamo with an equal quantity of copper, because, under however bad conditions such a machine may be put down, it will never show differences of 20 per cent.

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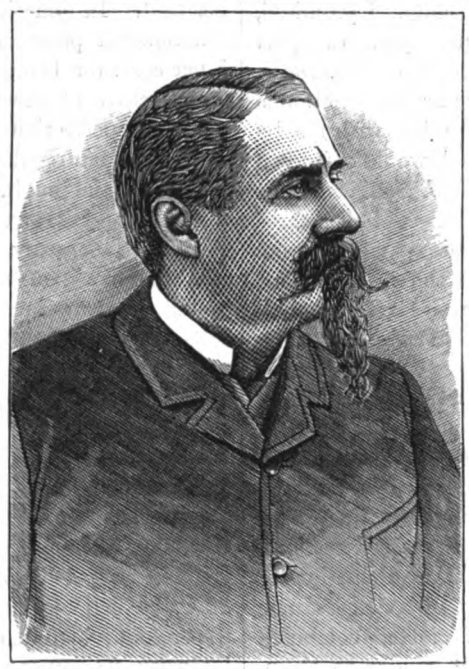
CHARLES FRANCIS BRUSH.

BRUSH, CHARLES FRANCIS, M.E., Ph.D., Electrical Engineer, Cleveland, U.S.A.; born March 17th, 1849, and grew to energetic boyhood. His parents were of old Eastern stock, and they gave their son a goodly bodily and mental heritage for his start in the battle of life. The early days of Mr. Brush were spent on the farm, after which he entered the public schools, his parents taking particular advantage of the excellent school system at Cleveland, where much better opportunities were afforded than nearer his home. While quite young the natural bent of the mind of the future inventor began to manifest itself, and he devised experiments at home and at school that indicated his special taste and aptitude for chemistry, physics, and engineering. In chemistry and natural philosophy, as indeed in his other studies at school, young Brush was very proficient. In 1862, while aged but thirteen years, he made his first experiments with magnets and batteries, and while at the High School, in 1864, he became much interested in the subject of microscopes and telescopes, making a number of them for himself and his companions. He constructed every part of these instruments, even to grinding the lenses. In the same year he devised a plan for turning gas on the street lamps, lighting it, and then turning it off again, by electricity. He also constructed a number of induction coils, and greatly amused himself and his school-mates by experiments with them. Having graduated in a four-years' course at the Cleveland High School in two and a half years, and continuing to show a fondness for physics and other studies of a similar nature, Mr. Brush entered the University of Michigan at Ann Arbor, where he took up a course of study particularly suited to his tastes, and by diligent attention to his tasks he graduated as a Mining Engineer in 1869, being one year in advance of his class. Returning to Cleveland from college, he organised a laboratory and conducted the business of an analytical chemist for about three years, becoming noted for the accuracy of his work and the skill displayed in his manipulations. Immediately after this he engaged in the iron business, in which he remained four years. He was married October 6th, 1875, to Miss Mary E. Morris, of Cleveland. In 1875 the attention of Mr. Brush was especially called to the subject of electric lighting, by experiments tried in Paris and London, and in a conversation with Mr. George W. Stockly, vice-president of the Telegraph Supply Company, the question came up as to whether there was not likely to be a demand for a dynamo machine of an entirely different construction to the Gramme and Siemens machines. Since the times of Volta and Faraday, the problem of using electricity as a cheap and practical illuminator had engaged the attention of the best inventive talent in the world. Although many steps in the right direction were taken, the results that were demanded seemed as far distant as ever, until many of those best posted gave up, and declared success to be impossible. Two things had to be invented. First, a dynamo machine that could generate the proper amount and kind of electrical current for operating a number of lamps in a single circuit. Second, a lamp that could successfully work upon a circuit with a large number of other lamps, so that all would burn uniformly. These two things must be produced, and simplified to such a degree as to make electric light cheaper than large quanties of any other artificial illuminant. As a result of the conversation with Mr. Stockly, it was arranged that Mr. Brush should be afforded any facilities that he might need in the factory of the Company at Cleveland, and if he produced such a machine as was required, the Telegraph Supply Company would undertake its manufacture and introduction. Mr. Brush departed without making any pledges, and constructed his machine in private, at his leisure. It is quite probable that he had already pretty thoroughly worked out the problem in his mind. In less than two months from the time mentioned, Mr. Brush brought his machine to the factory on Champlain-street. It was set up in the shop, connected by wires to an old clockwork electric lamp with carbon points, and by a belt with the main shaft. The brushes were adjusted, the armature revolved, the current of electricity was generated, and the lamp gave forth its brilliant light. It was a complete and gratifying success. Of course many mechanical and a few electrical changes in Brush machines have since been made, and the immense sixty-five light machine of the present, absorbing forty-five horse-power, is not to be compared with the infant of three hundred candle-power. But the invention was substantially completed and embodied in this first essay, and has not been departed from materially since. The machine having been obtained, now for the lamp! Mr. Brush believed that he could make a satisfactory commercial lamp as well as a practical machine, and he proceeded to his second task. This was accomplished within a few weeks. The lamp proved to be an invention almost equal to the machine itself, and as at present constructed it is substantially the same in form and principle as the one first produced. At this time Mr. Brush was less than twenty-eight years of age, but had achieved the beginning of the great success that the world now appreciates and enjoys. The capital now invested in the electrical business as an outcome of the Brush light and its accessories is estimated at over twenty-five million dollars, and the amount is growing larger every day. The most prominent of the inventions of Mr. Brush, manufactured by the Brush Electric Company, are the dynamo electric machines, electric lamps, automatic current governors, carbons, batteries for the storage of electricity, apparatus for electroplating, apparatus for producing power from electricity, &c. Mr. Brush possesses an accurate and available scientific knowledge unsurpassed by that of any inventor. He is a self-taught mechanic, and is able to do shop work equal to the best trained men. He is intensely practical, never sanguine, with no disposition to over estimate his work, and is an excellent business man in the management of his own affairs. If an exceedingly delicate or accurate piece of work is to be done for the first time, he will probably do it with his own hands in his laboratory. He usually spends from 10 o'clock a.m. to five p.m. in his sanctum, busily engaged in one of his numerous undertakings or investigations. With the whole resources of a large manufacturing establishment, filled with the most costly and convenient machinery at his command, he probably has the best facilities for experiment and demonstration of any living inventor in the electrical field. In 1869 the University of Michigan conferred upon him the degree of M.E. In 1880 the Western Reserve University invested him with the degree of Ph.D.; and in 1881, in connection with the Electrical Exposition held in Paris in that year, the French Government, in honour of his distinguished inventions, services, and contributions to the world of science, decorated him Chevalier of the Legion of Honour. At the Michigan University he was a member of that famous college society, Δ K. E.



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OLD CABLE STORIES RETOLD.—VII.

BY F. C. WEBB.

(CONTINUED FROM PAGE 511, VOL. XIII.)

THE RED SEA AND INDIA CABLE OF 1859—1860.

The British Government never took any very deep interest in Atlantic cables, but they were very anxious, even as early as 1858, for telegraphic communication with India, and in 1859 a company had been formed for laying cables from Suez to India, having a guarantee of 4 per cent. for fifty years, whether the cable worked or not, for no money could be raised then on a guarantee conditional on the cable working. The cable was to start from Suez, and touch at Cosipe, Suakim, Aden, Kooria-Mooria Islands and Muscat, ending at Kurrachee.

Messrs. Newall and Co. had the contract for making and laying the cables, and by the middle of 1859 the sections from Suez to Aden had been laid from the steamers "Imperidor" and "Imperatrix."

Towards the latter part of 1859 I was engaged by the Red Sea Telegraph Company to proceed to India and test the sections about to be laid from Aden to Kurrachee, and on the 9th of November I started for India *viâ* Paris. On the 10th I was assisted in getting my instruments, &c., passed through the Custom House at Paris by my old friend Mr. Spiers (father of the Mr. Spiers of refreshment room improvement celebrity). Mr. Spiers always knew the best piece to see at the theatres, and where best to dine. That day we dined together at Vefours. He was a Director of the Submarine Telegraph Company, and so knew something of submarine cables, and as he was agent to the London General Steam Navigation Company he was well known by the Custom House authorities. He gave me letters to friends at Marseilles to facilitate the clearance of my instruments there. He was a genial, kind-hearted man and good man of business, and I never used to pass through Paris on any of my trips without calling on him, but can do so no more, as he died some three years ago. I arrived at Marseilles on the 11th. The English mail "Vectis" was quite full, so I had to take passage for Alexandria in the Messagerie Imperiale steamer "Danube," which started on the 13th. During my stay at the Hotel des Ambassadeurs I made acquaintance with Mr. Stanley, the Consul at Jeddah, in the Red Sea, and soon found he was another of my old Brussels schoolfellows. Jeddah had some months before been the scene of a massacre; the English Consul had been killed, and H.M.S. "Cyclops" had been ordered to bombard the town. Then this order was countermanded, but the ship carrying the message of countermand in some way passed the "Cyclops" in the night, and went on past Jeddah, and the "Cyclops" arrived and bombarded, but did it in a merciful way, for after the first few shots they slung a 68-pounder and fired right over the town to show what they could do if they liked. The "Cyclops" had been taking soundings in the Red Sea, &c., for the cable, and was one of the ships that I was afterwards on board for a month.

We arrived at Alexandria on the 20th. Mr. Brunton (formerly under Mr. Statham at the Gutta Percha Works, Wharf-road) was the general manager of the line, and was at Alexandria, and I reported myself to him. Mr. (now Captain) Mayes, R.N., was also there. He had been master of the "Cyclops," but was at the time I allude to in the service of the Red Sea Telegraph Company, and was to have the command of the repairing ship. This ship had not arrived out up to the time I left the whole work, and I am not sure that she ever came out at all. I don't know what her name was or who fitted her up, or when she was bought. She seemed to me a kind of "Mrs. Harris," although, I suppose, she must have had some sort of existence. Mr. Gisborne (a relative of Mr. Lionel Gisborne, the engineer) was the superintendent at Alexandria, and I lunched at his house on the 22nd. He had a beautiful little tame gazelle that strolled about in the dining room.

On the 23rd I went on to Cairo. For some distance from Alexandria one of the land lines had L. Clark's double cup insulators. I put up, of course, at Shepherd's. On the 24th I did the Pyramids with two American gentlemen named Fetridge and Millar, who had been fellow passengers with me from Malta. I could have got up to the top of Cheops without any great stress of muscle or breath, but that the Arabs who drag and pull and push at you got singing such ridiculous bits of broken English, ending each stanza with "Oh! Englishman very good man. He give backsheesh when he get to the top!" that I got into a fit of laughter, and the more I laughed the faster they pulled, so that when I did get to the top I had no breath left at all, and could only lie down on my back and pant for a good ten minutes. A lady who was at the top said that all the others that came up were red in the face, whereas I was deadly pale. The fact was, I believe a little more and the Arabs would have been dragging up a smiling corpse. I made a sketch of the other pyramid from the top of Cheops, and have it now. After lunch we went inside the king and queen's chambers, and then looked at sphinx, and I took a sketch of that. Then back to Shepherd's by 7 p.m. to dinner. When chatting with my two American friends one said, in the course of a political question, "Why on earth don't you Britishers take Egypt and have done with it?" I thought it a very good idea, though I don't know that it was a very novel one, and have no doubt if we had taken it in '59 or '60 the country would have been by this time in a respectable and settled state.

On the 25th I did the mosque, &c. In the evening the passengers from Bombay arrived, and I suppose it would be difficult to find any hotel where passengers arrive in such great crowds all at once as at Shepherd's. It was a very curious scene of confusion, bustle, and jabber, with a band playing outside to add to the general noise. It may be more so now, or less if there are more hotels, that I cannot say, but at that time it was one of the most curious sights I had ever seen.

I started for Suez on the 26th, at 8 a.m., by a train that was not taking the eastward general flood of passengers through. There was only one second class carriage, and no first class. My two American friends, two French ditto, Mr. Stanley, and Mr. Sheath (formerly clerk in charge at the Hague) were with me. A water train broke down in front of us when we were about half way to Suez, and stopped us for an hour. There were four railway wires, with Edwin Clark's zinc cap insulators. The Red Sea telegraph line had Siemens and Halske insulators, and this line did not keep to the railway, but made short cuts in different places. We got on to a station in the desert, and had some lunch at this station. It was only a station; there were no houses or huts. I found there a telegraph clerk who I had known in the Electric Telegraph Company. It was quite delightful to find a friend in such a lonely place. We got to Suez about 2 p.m., and I saw my friend Mr. Stanley start off for Jeddah in an Egyptian steamer.

The hotel at Suez was a very different place to what I expect they have there now, and there were very few people in it. In the evening we were smoking a cigar in the proprietor's room. There was an English baronet, who was on his way to New Zealand, and he had about a dozen partridges that he was taking out to his lands there. He had started from England with seventeen more, all of which had died up to that time. The remainder were therefore getting very precious, considering the percentage that had died and the distance still to be traversed to New Zealand. The birds were in cases with a kind of cage-front made of battens, and had been brought up into this room and placed with the battens against the wall. Now the master of the hotel had a tame mongoose. The little creature had been running about the table and amusing us with his pranks. He had disappeared, and we were chatting, when suddenly the baronet jumped to his feet, rushed like a maniac at his cages, tore off some battens, and the next instant the mongoose was high in the air describing a trajectory to the other end of the room. But five more of the partridges had gone the way of their own majority. The little sly wretch of a mongoose had got in between the wall and the cage and then between the battens, and would have slaughtered the whole lot had not the owner of the partridges heard a faint cry from the fifth. I always wondered, firstly, how it was the baronet did not get bitten, for he had seized the mongoose regardless of consequences;

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secondly, how it was the mongoose was not killed when he struck earth (or floor); and lastly, I always wondered whether the baronet ever got a single partridge to New Zealand. I hope he got a brace there, for he was a very nice fellow, and I had travelled with him from Marseilles; but his case was not hopeful at Suez. In fact, from the above particulars I should estimate, as an engineer, that to get a couple of brace of partridges to New Zealand from England you ought to start with at least a thousand.

I am afraid this is scarcely about cables, but you must recollect, Mr. Editor, that I am, or was, waiting at Suez for a ship to take me on to Bombay. On the 27th I went with my American friends, Fetridge and Millar, in a boat to Moses's Well, about ten miles down the Red Sea, on the Arabian coast. It was a Sunday morning, and one of the Americans was of a rather serious turn of mind, and wore spectacles, and he took his Bible with him, and as we sailed along endeavoured to glean from the Arab boatmen something about any traditions that might exist as to where the Israelites crossed the Red Sea. He had his Bible open, and was constantly asking questions of the boatmen, who gave answers which, as far as we could make out, gave us no information, indeed continued to puzzle us more and more. At last the less serious of my two friends said, "Now, let me try to get at it;" then to the Arabs, "Now, look here, *who was it* that were after the *Israelites?*" There was instantly a chorus of "*Rascally Bedouins, sar!*" They thought we were talking of a murder that had taken place three weeks ago, when some poor traveller was murdered by some Bedouin Arabs. The serious American shut up his Bible, and his friend indulged in a tremendous fit of laughter, and afterwards wrote in the visitors' book at Suez Hotel, "Discovered that the Israelites were not pursued by the Egyptians, but by rascally Bedouins," and signed it "A Seeker after Knowledge." There was not much to see at the wells. There are fifteen wells with the crazy picturesque water wheels carrying an endless rope with small earthenware pots to bring up the water. There were two or three huts there, but one of these we could not go into, because some ladies from a harem were there. A jolly old Arab lent us two camels to ride back to the boat, and the jovial American and I rode on one, and we were greatly amused at the peculiar motion and the groans the animal uttered when made to lie down by the Arab in charge.

ELECTRIC LIGHTING IN AMERICA.*

BY W. H. PREECE, F.R.S.

Electric lighting is flourishing in America much more than at home. There are, probably, 90,000 arc lamps alight every night in the States, and there are many central stations working regularly, both with arc and with glow lamps. I know nothing more dismal than to be transplanted from the brilliantly illuminated avenues of New York to the dull and dark streets of London. This has happened to me very recently. On the evening of October 21st, I drove from the Windsor Hotel, New York, to the Cunard Wharf, a distance of about four miles, through streets entirely lighted by electricity. On October 30, I drove from Euston to Waterloo without seeing a single electric light, having been on the ocean during the intervening period. I visited Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, Boston, and New York; finding in each city the principal streets and warehouses, as well as stores and places of public resort, lighted by arc lamps. After so much brilliance in these cities, the return to dull gas has a most depressing influence. It is with arc lighting that the greatest advances have been made in the States. One manufacturer alone told me that he was turning out 800,000 carbons for arc lamps per month, and another said that his output of plant was fifty arc lamps and three dynamos per day; and while I was present at a third factory, an order was received for an electric lighting plant of 330 arc lamps requiring fourteen 24-light dynamo machines, intended for an installation to light up a driving park in the environs of Chicago. As an instance of the growth of electric lighting, I may mention that in Chicago the number of arc lamps installed has doubled, viz., from 1,000 to 2,000, during the past twelve months, and the number increases daily. More than one electric light company pays dividends to its shareholders, and all of the manufacturers as well as the lighting companies seem to be full of work. The principal systems in use are, for arc lamps—the Brush, the Weston, the Thomson-Houston; but there are other arc systems, not so well known on this side of the Atlantic, such as the Hochhausen, the Van de Poel, the Western Electric, the Fuller, the Sperry, &c. For glow lamps—the Edison, and the Weston. I will describe briefly the systems I saw in use, dividing them into (1) arc systems and (2) incandescent systems.

* Paper read at Society of Arts on Wednesday, December 3.

I.—Arc Systems.

The Brush System is so well known that it scarcely needs any reference, excepting to point out that a very considerable improvement has recently been made in the dynamo machine, which has very largely increased its capacity and output. The new Brush armature consists of layers of thin sheet iron, insulated from each other. By this arrangement induced currents—improperly called "Foucault" currents, for they were fully described by Joule as far back as 1843—which produce heat, and thereby diminish the efficiency of the machine, are prevented from being formed; and, further, should heat arise through excess of current, thorough ventilation is effected to carry it away by convection. Brush dynamos, which previously, with the old armature, lighted sixteen and forty lamps respectively, now, with the new armature, excite thirty lamps and sixty-five lamps; so that it will be seen that the improvement is very considerable.

The Weston System.—This system, looked at from a mechanical point of view, strikes one as being probably the best in use in the States. The machine itself is of the Siemens form, but the armature is made up of discs stamped out of thin sheet iron, and separated from each other by washers. By this method, first suggested by Joule in 1843, those disturbing induced currents are entirely checked, and thereby the undue heating of the armature prevented. Mr. Weston appears to have been the first to have practically carried out this very sensible idea, and it is being rapidly adopted by other makers of dynamo machines. I have mentioned that Mr. Brush has followed out the same idea. The commutator in the Weston machine differs from most American commutators, in that it has no less than 140 segments, which tend to prevent "sparking," a very disturbing element in the action of dynamos. In fact, the absence of sparks is one of the striking features of this machine. There are standard Weston machines for working arc lamps, and also for working glow lamps. Both kinds are shunt wound, the former being supplied with a most sensitive and extremely ingenious regulator, which adjusts the strength of the shunt current or field magnets, so as to maintain the current in the main line constant. The 200-lighter Weston dynamo for glow lamps is peculiar in the extreme lowness of the resistance of the armature, which is only ·0011 ohm, while the resistance of the shunt is 24 ohms, thus having a ratio between them of 1 to 2,182. The result of this lowness of resistance is such that the resistance of the armature may be neglected, and therefore the dynamo becomes self-regulating. I saw 199 lamps out of 200 suddenly extinguished, without producing any apparent change in the incandescence of the one glow lamp left. The electromotive force of this machine is seventy volts when rotated at 1,000 revolutions per minute. The arc lamps of the Weston type do not call for special notice, excepting to record the remarkable steadiness of their burning. They are fed on the differential principle, but they owe their steadiness and good working to the perfection of workmanship and the mechanical finish of their parts. The beautiful suspension bridge at Brooklyn is lighted entirely by eighty-two Weston lamps. This is done by the bridge trustees themselves, and the view of this bridge at night from Staten Island and from the magnificent harbour of New York is one of the prettiest optical effects I have ever seen. New York harbour will soon be so brilliantly illuminated by electric lights that one of the enterprising ferry companies contemplates having nightly excursions, which it is intended to advertise as the "Theatre of New York Harbour by Electric Light; price of admission 10 cents." Local companies using the Weston arc system are successfully operating central stations, supplying a large number of lights for rental at Boston; Springfield, Manchester; Providence, Rhode Island; Newport, Rhode Island; New York City, Rochester; Elmira and Glen Falls, New York; Newark, Cape May; Atlantic City, &c.

The Thomson-Houston System.—This system is unknown at present in England. It contains some considerable and ingenious novelties. The armature is spherical, and is almost entirely encased by the field-magnets; the magnetic field thereby becomes enclosed, and is very intense. The dynamo is series wound. The commutator consists of only three sections, and there are only two pairs of brushes. It has an automatic governor, which adjusts the lead of the brushes to positions of varying electromotive force as the work itself varies, so that, however much the number of lamps may change, the current remains steady. It has a peculiar air-blast device, to prevent undue sparking at the brushes; strong currents or puffs of air prevent the formation of those lines of minute conducting particles which bridge across the air spaces at the commutator, and whose presence forms one cause of so-called "flashing," and they blow out the sparks which would form at the brushes. The arrangement also admits of the free oiling of the commutator, a point of very considerable importance, at a place where there is so much wear, and a peculiarity of this dynamo. The ordinary size Thomson-Houston dynamo lights up twenty-five arc lamps, and it has 225lb. of copper on the armature, and 700lb. on the field-magnet. When rotated at the ordinary speed of about 900 revolutions per minute, it acquires an electromotive force of 1,200 volts, and generates a current of 9·8 amperes in the lamp current. The lamps have an average resistance of 4·5 ohms, and the electromotive force that each lamp takes is 45 volts. A 25-lamp circuit absorbs 23·25 horse-power. The commercial efficiency of this machine is therefore 80 per cent. Frequently as many as seven of these dynamos are joined up in series. An interesting example of lighting is that of a new swing bridge crossing the river at Rush, near Chicago, which is moved with promptitude and lighted with brilliance by steam engines fixed in the centre of the bridge. All connection with the shore is cut off, but the whole thing works with great steadiness, although a heavy traffic, four abreast, is maintained all day long.

The Hochhausen System.—This is slightly known in England, from its employment in the recent International Health Exhibition to light up the tall mast in the centre of the gardens, but it has scarcely received the

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attention that it merits. It is doing a large business, but I did not visit any places worked by it.

Central Stations.—I visited the central station of the Thomson-Houston Company at Montreal. It was opened on the 14th March last, and on September 3rd, when I was there, there were 164 arc lamps alight in the public streets and shops of the town. The wires through the town were all of copper, principally No. 6 gauge, covered with cotton and asbestos, and were in all cases carried through the streets on unsightly posts. The rate charged is 50 cents per lamp per night, the lamps being lighted from dark to midnight; this means over £35 per lamp per annum. I visited other central stations worked on this system, and I learned that it was decided to light up the public streets of Ottawa entirely by the Thomson-Houston system. In that case the power will be obtained from the celebrated Chandére Falls, that add so much picturesqueness to the position of Ottawa and wealth of its inhabitants, for it is the great source of power used to carry on the timber trade of the place. Another central station that I inspected was that of the Brush system, at Philadelphia; there 1,200 horse-power was employed in supplying electricity for nearly 1,000 lamps. As in Montreal, open wires are used, supplying 25 circuits, some of which are four miles long. The charge for each lamp is 25 dollars per month, which is equal to £60 per lamp per annum. The Brush people have also two central stations at Boston, lighting up 816 arc lamps; in fact few towns of any consequence in the States do not possess central stations worked by the Brush Company. There are, probably, 25,000 Brush arc lamps in use in the States. At Chicago there are now over 2,000 arc lamps going, and they are increasing in number every day. The Lincoln Park has all its drives lighted by arc lamps, with very great effect, especially on the unique drive skirting the shore of Lake Michigan. There are several central stations belonging to various companies in Chicago, viz., the Western Electric, the Van de Poel, the Fuller, and the Sperry Company; while the Hochhausen system is about to be started with a central station for several hundred lamps. I did not observe any particular novelty in the form of lamps used, and the impression I gained was that there were some European lamps that far surpassed the American ones in steadiness and efficacy.

Street Lighting.—I did not see in the States one single instance of street lighting by glow lamps. In every case arc lamps were used for this purpose, and they were usually fixed on much taller posts than we are accustomed to see in England, arranged in zigzag fashion along the streets, at a distance from each other of about fifty yards. Although the effect of this street lighting by arc lamps was brilliant, it was by no means perfect, and no effort seems to have been made to distribute the light uniformly, as has been done in England by Mr. Trotter; and, in fact, the question does not seem to have been attacked at all from a scientific point of view; the commercial spirit alone appears to have been exercised in developing this enterprise. An interesting experiment has been tried in Cleveland, where eight Brush lamps are fixed upon the tops of four iron masts, each about 250ft. high, fixed in prominent positions in the city. These masts were made of riveted boiler plate. They were erected *in situ*, and raised by jacks as they were made. The diameter is 8in. at the top and 3ft. at the bottom; they cost £800 each. I am bound to say that, to me, the effect was very poor; the streets were illuminated only by a light equal to a very pale moonlight, concentrated, as it were, at one end only. There are 300 other arc lamps in Cleveland. At St. Louis, the Court House in the centre of the town was surrounded by permanent arc lamps, but except for illuminating the dome of the Court House itself, the effect upon the contiguous streets was poor. Here one of the streets was lighted by two arc lamps on each pole on one side of the street, and the effect was certainly indifferent, and gave one the idea of a great waste of light. Washington has been experimentally illuminated by the Brush-Swan Electric Light Company, by very large arc lamps, 4,000 candle-power each, fitted with large conical reflectors, throwing a great body of light down the streets to be illuminated. The various avenues radiating from the Capitol are thus lighted, and a circle of 14 lights, without reflectors, surrounds the top of the Capitol, the effect of which, I am told, is certainly very fine. I have since learned, however, that, after an experimental run of 45 days of these lights, the commissioners empowered to decide upon the success of the experiment have given their veto against its continuance. It is, perhaps, interesting to point out that the price paid in New York is 70 cents per night, or £50 per annum for each arc lamp; but a fine is inflicted on the lighting company of 1·40 dols. for each time that each lamp is reported to have been out; a healthy check is thus kept upon the good working of the system.

(TO BE CONTINUED.)

FATAL ACCIDENT FROM AN ARC LAMP.

At the inquest held on the unfortunate lad, William Moore, aged 19, who was killed by an electric shock through touching a Brush lamp at Bolckow, Vaughan, and Co.'s steelworks, Eston, Middlesbro', on 25th November, the following facts were elicited:—

William Broughton, an engineman, deposed that early on Tuesday morning deceased, who was employed at the works as oiler and cleaner, called his attention to a hot bearing, and, while he went to look at it, he heard him call out "Oh, Bill!" On looking round, he saw a number of men, who had rushed to the spot, picking up the deceased, who seemed quite dead. The electric wires were about 3ft. over the men's heads; and it was no part of the business of either witness or deceased to interfere in any way with the light. If it should go out they were instructed to send to the electrician's office, and a man would be sent to re-start it. Notices were posted in all available places in the works warning men not to touch the lamps or the wires. When the light goes down, a tap or two with a stick would bring it up again.

George William Parker, engineman, stated that he saw the deceased on the engine house stage. When the electric lamps went out, deceased picked up a piece of stick and tried to light the lamp. Deceased seemed to place his hand on one of the rods, when a connection seemed to be made. Witness was running towards the electric engine to get it stopped when deceased fell. He did not see deceased take hold of any other part of the lamp. Witness had seen the notices warning men of the danger of touching the wire.

Walter Blower, electrician for Messrs. Bolckow, Vaughan, and Co., said that the following notice was posted all over the works:—"Danger. We caution the workmen not to interfere with or touch the wires, lamps, or connections of any kind belonging to the electric lighting. By order." He knew the deceased, but had not seen him interfere with any wire. He was constantly cautioning the men, and on Thursday last, while in the engine house, he cautioned the deceased and the witnesses. By taking hold of the bar mentioned by the last witness, one came in contact with the circuit, and the effect of that was seen by the death of the deceased. Witness saw deceased after the accident, and noticed that his right hand was scorched, which proved that he had made the circuit.

Dr. John Glen said he had made a post mortem examination of the body of deceased. There were no external marks of violence, only slight abrasions of the skin. The palm of the right hand was scorched, as though deceased had taken hold of a red hot bar. Upon making an examination, he found all the internal organs healthy, but highly congested; the brain was also perfectly healthy. From that examination he came to the conclusion that the cause of death was a violent shock, owing to coming in contact with electricity. The effect was very similar to lightning; but in this case he should say that there must have been actual contact.

The jury returned a verdict that deceased had died from a shock received through his having taken hold of the wire attached to the electric light.

In this case, both lamps and wires are evidently placed out of the ordinary reach of the workmen, and abundant warning given not to touch them. The deceased met with his death through interfering with what not only did not concern him, but what he had been warned in every way not to meddle with.

PARLIAMENTARY NOTICES FOR NEXT SESSION.

The Corporation of Ramsgate, in the Bill which they have notified their intention of introducing in the next Session of Parliament, ask for powers authorising them to provide and maintain for their establishments or offices telegraphic or telephonic communication between any parts of the borough, and for such purposes to incorporate, extend, or apply all or some of the provisions of the Telegraph Act, 1863, or any other Act or Act amending the same.

The Corporation of Hastings will ask for powers in the Act for which they intend to apply to provide for the regulation, alteration, and removal of pipes, tubes, wires, and other apparatus connected with telegraphic, pneumatic, telephonic, electric, and other purposes within the borough, and to establish communication by any such means between the Town Hall and the several offices of the Corporation.

Authority will be asked for in the Act which the Corporation of Wigan will apply for empowering them to prohibit or regulate by license or otherwise "the placing or maintaining of wires, conductors, cables, tubes, or other projections, works, or things, over, above, along, across, or beneath streets or other public places within the borough."

In the Bill which the Corporation of Bradford notify their intention of applying for clauses will be inserted empowering them to erect and maintain electric lines and works, and to supply electricity within the borough.

By the Act which will be applied for to extend the limits of the Local District Board, or (as the case may be) the Municipal Borough of Mossley, provisions will be made "for licensing, regulating, and otherwise in relation to the fixing, placing, or attaching of telegraphic wires, tubes, and apparatus."

The Corportion of Lincoln intend asking for leave to introduce a Bill authorising them to acquire the undertaking of the Lincoln Gaslight and Coke Company, and to empower them "and (if deemed expedient) to the exclusion of any other person or company (*a*) to produce, store, distribute, and supply, for public or private purposes, within the gas supply district of the Corporation, light, heat, or motive power by means of electricity or any light (other than gas) produced by artificial means or power, and for those purposes, or any of them, (*b*) to exercise all or any of the existing powers of the Company or the Corporation relative to lighting by gas, or oil, or such other powers, rights, and privileges as may be conferred by the Bill," &c.

The Chelsea Electricity Supply Company (Limited) notify their intention of applying to the Board of Trade, on or before the 20th inst., under the provision of the Electric Lighting Act, 1882, for a provisonal order empowering them to produce, store, and supply electricity within the parish of Chelsea. For these purposes authority will be asked for "to enter upon, break up, and interfere with," all streets, railways, tramways, gas and water pipes, telegraph and other wires and pipes, &c., and to enable the Company to manufacture, hire, sell, and let all necessary machines, plant, &c., required for the purposes of the order; to acquire land, levy rates, &c.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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ANSWER TO CORRESPONDENT.

J. H. D. (Moscow).—*Your letter has been handed to a gentleman who will write you fully on the subject.*

THE JOURNAL OF PATENTED INVENTIONS.

We have looked forward with some impatience to the publication of the illustrated journal which, under the provisions of the Patent Law Amendment Act, was to be issued from the Patent Office for the information of the patent-loving public; and we have at length received the first number. Upon a very cursory examination of its contents we find many things to speak about; but, first of all, we desire to give it a welcome none the less hearty because of the faults we have to find with it, and the delay which has occurred in its publication. It bears date November 28th, and brings its information down only to February 11th; but as it is to be issued weekly the lost time, perhaps, may be soon made up. When we ourselves, in common with other technical journals, essayed to summarise and illustrate inventions even of a limited and special kind we found it impossible to keep up the pace; and for this and other reasons the attempts have generally been abandoned. The official journal is now to assume the task on a broader basis; and in the hope that it may be performed in a thoroughly satisfactory manner we take leave to offer some friendly criticisms on the first number.

At the outset we must protest against the price of the *Journal*. A shilling is, from every point of view, twice as much as it is worth, and is, we apprehend, prohibitive; whereas at fourpence or sixpence it might stand a chance of paying for its production. Subscribers at a guinea a year might be reckoned by hundreds, where a subscription of two and a half guineas will be counted by tens. In this connection we would suggest a small addition to the outlay upon the Index. It seems to have occurred to the compiler at the last moment that an index is demanded nowadays with any book pretending to completeness; and he has given us one—one that is unique of its kind. It is an index, not to the subjects of the inventions, as would naturally be looked for, but to the numbers borne by the patents relating to them. Thus we are informed that patent No. 1,692 will be found at page 19, a piece of help which nobody needs, seeing that the numbers are arranged consecutively. A blunder of this kind is characteristic of the official mind. In the routine atmosphere of the Patent Office an invention appears to be like a convict in penal servitude, it becomes a mere number, a thing to be traced, but not to be recognised. We would say to the ingenious compiler, A fig for your numbers; let us know what they stand for!

Turning to the contents of the journal, there is evidence of the same unpractical mind at work. Prominence is here again given, quite unnecessarily we think, to the number. It is of no more importance than the date, which ought certainly to come last, whereas it immediately follows the initial number. The title of the patent is in prominent type, which is good; but why is it relegated to a third place? It ought to be most prominent of all, and as far as type can make it, no fault can be found on this score. But the effect of giving it a third place and generally to split it up into two lines is not only "spotty" from a printer's point of view, but confusing to the reader—or rather searcher, for we are dealing with what is essentially a book of reference, where every trifling detail should conduce to the easy finding of what is being sought. Taking examples at random, what can be more vexatious than the splitting up of titles in this manner:— **Regulating flow; Packings for; Pruning or bill**—all of which occur on page 25, to say nothing of **Window venti-**, the context of which may perhaps be guessed at without diving into the next line. The titles are uniformly short, and they ought to appropriate the first line as a distinct heading. **Automatic spe-** (page 22), **Balanced ther-** (page 14), are inexcusable divisions; and **Adjustable chin, Preserving, &c.,** on page 6, are absurd. Speculum and thermometers, we may explain, are the words needlessly severed; and the adjustable chin has nothing to do with anatomy, but relates to a chin-holder for violins; whilst the fourth example refers, not to preserving of either jams or *etceteras*, as a first glance might lead us to suppose, but to the preserving bottoms of ships. A first glance ought to suffice; the compiler of the *Patent Journal* compels us in most instances to take two.

With the wood cuts which profusely illustrate the *Journal* we have no fault to find on the score of workmanship. As a rule, they are admirably done, and like the letterpress, are excellently printed. But the engravings are not all of equal merit, and one or two of them are a disfigurement. This much for the engraver. But who is responsible for the respective space assigned to each figure? Not the engraver, we feel certain, for he would never sacrifice clearness to economy in the way it has been sacrificed over and over again in these pages. For the original drawing the office is, no doubt, indebted to the patentee; but we may be sure he made his meaning clear, if he had any. To look at some of these diminished reproductions one would suppose he had none. At least twenty per cent. of them are utterly unintelligible; and, for all the light they throw upon the text, the money spent

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on engraving them is clean wasted. No discrimination appears to have been exercised in this particular. Take for example, again at random, page 3. There is the outline of a Shirt, the essential point about which might be indicated within the area of a lady's finger nail; yet it occupies space half as big again as that allowed to a Burglar Alarm, with complicated details which nobody can follow on such a reduced scale. A Tobacco Pouch on page 4 is favoured like the Shirt, and so is a certain, or rather uncertain, Egg-cup which we decline to advertise more particularly; whilst a Weighing Machine and a Padlock, on page 15, are obscured by unnecessary detail, or detail too minutely traced to be followed. On the same page is a picture of a bookbinding press, the like of which we hope never to see repeated. It is a picture, and that is all.

We have left ourselves no space to speak of the inventions which these pages are intended to usefully make known to the world. As a first instalment of the new patent law they do not strike us as particularly startling in anything but their numbers, which on the 11th February had reached 3,094. This at least represents the number of applications during the first six weeks of the present year. As to the amount of inventiveness disclosed we cannot at present form any positive opinion; but we are certain that we shaved our editorial chin —not adjustable—fifteen years ago with the identical razor depicted on page 15 as a new invention; and it cuts our corns fairly well even now.

CORRESPONDENCE.

THE SILENT ELECTRIC ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The very interesting paper on the silent electric arc in your last impression needs, I venture to say, some explanation, which the author will perhaps give.

I have made hundreds of experiments in arc lighting, and I can corroborate much that Mr. White says, but not all. I find, for example, that too many amperes will cause carbons to hiss, no matter what the arc; also that only good carbons are silent, no matter what the arc. I may perhaps add that the author has not explained why an arc is silent.

But the point on which I want information is this: All my experience with self-exciting Gramme machines is that as the length of the one increases so does the E.M.F., while the number of amperes decreases. This is not the result got at by Mr. White. For example take Table I.; we have amperes 10·59, volts 39·94, amperes 13·59, volts 40·61, and so on. Furthermore, it appears that as the distance between the carbons is augmented the resistance diminishes; my experience is that it augments. If not, will Mr. White kindly explain to me why it is that, as the carbons burn further apart, the number of amperes steadily diminishes, and that just the same result can be brought about by putting a resistance into the circuit. One of the lamps with which I have experimented depends for its action entirely on the diminution in the number of amperes as the carbons burn away, and it works perfectly; but I need not argue the point, for Mr. White's own figures prove the diminution, only he leaves the volts unaltered.

Not to take up more of your valuable space, I venture to ask why it is that doubling the distance between a pair of carbons will reduce the resistance of the coil from 6·23 ohms to 2·07 ohms? In the first case, too, we have 5·94 ampere and 37 volts. Now $5{\cdot}94 \times 37 = 219{\cdot}78$ watts, the separation being 1¼mm, or say $\frac{1}{20}$th of an inch. In the second case we have 20·3 ampere and 42·15 volts and $20{\cdot}3 \times 42{\cdot}15 = 855{\cdot}64$ watts. This is an exceedingly puzzling statement as it stands. The separation of the carbons was 2·77mm., or say ·108 inch in the last case. Are we to understand that this great increase in electrial energy was due to the burning further apart of the carbons—that, in short, it resulted from the descent of the resistance from 6·23 ohms to 2·07 ohms?

My own experience has always been that the shorter the arc the greater the load thrown on the engine, for obvious reasons. In the case cited, however, it would seem that the longer the arc the greater the work thrown on the engine.

I never yet succeeded in getting a silent arc with a separation of less than 0·1in., and some of my best results have been with an arc of $\frac{3}{16}$in., about 42 volts, and 11 to 12 amperes for 11mm. carbons.

Great thanks are due to Mr. White for his very original work in a new field of research. I am sure that if he will favour your readers with the explanation I ask for others will be grateful as well as—Yours, &c.,

Dec. 2, 1884. A PRACTICAL ARC.

SELF-REGULATING MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue I see that my friend, Mr. William Macgregor, has been taking up the cudgels on my behalf in the matter of compound-wound machines. In the main his statements are correct (except some amusing vagaries of the printer's devil as to proper names). Your editorial note, however, contains news to me, that there is claimed for Mr. Edison compound winding as his prior invention. As a fact, though, I do not think my claim to be the first to apply double winding *to the definite purpose of supplying the current at a practically constant electromotive force* has been successfully set aside, even by Mr. Edison's claim. For I pointed out in my book on electric lighting, published in 1879 (and written in 1878), in describing Mr. Brush's "teaser" arrangement, that there were other useful applications than to the purposes of plating; and I had in mind in writing that sentence (p. 83) the double winding I afterwards developed. Any claim of Mr. Edison's was quite unknown, it would seem, to the U.S. Patent Office Examiners in 1881, as no reference was made thereto by them in their examination of the claims for my patents, although many instances of *merely* double winding were adduced by them, some of these being now nearly thirty years old. However, as I say, I still believe I have been the first to practically carry out double winding with the definite law and purpose of supplying parallel circuits at a constant electromotive force. But I have no desire to be too persistent in what has now chiefly a bibliographic value, for compound wound machines have, as to true economy in electric lighting, only a limited use. It is amply proved by the performance of Mr. Weston's recently introduced dynamos that, given a sufficiently powerful field and a very low resistance, armature simple shunt-wound machines are self-regulating. The ends to be attained satisfactorily by compound machines are supplying current to a small number of lights in parallel circuit, where the resistance of the armature as determined by the dimensions of the machine must be comparatively high, or to the supply of several branch circuits in the electrical transmission of power to a considerable distance from one generator. As to the supplying of current for incandescent lighting with true economy as a whole system, I have had a painful experience that it is not to be done with any method employing the power obtained from engines directly; because the variation in the speed of the engine is in itself too great for long life of the delicate filaments of the lamps. In the case of the very admirable Edison installation in New York, we are told that the lamps average only 400 hours of lighting, although here probably the greatest care practicable has been taken to ensure steady running and a low incandescence of the lamps. It is a matter of common knowledge to electricians to suppose that lamps run from a machine direct blacken or break much sooner than those in circuits in which accumulators are interposed. In my professional practice I have during the last two years been in charge as consulting engineer of a large installation, partly run from dynamos with accumulators, and parly from dynamos directly, and both parts from the same source, a very excellent steam engine. In the

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one case no lamps have been broken, except by accident; in the other renewals of lamps are the rule. It is for these reasons as to the fallibility of any mode of winding that I hope you will absolve me from undue pertinacity in my claim as to compound winding.

Will you permit me to add a few words in conclusion? I do not think compound-wound machines have been generally constructed on the best principle. It seems to have been overlooked, that with both shunt and main coils wound on the same limb of the electro-magnet, an excess of iron in the electro-magnet core is in practice necessary to secure proper regulation [flatness of curve in diagram]. In the method of winding on separate limbs proposed by myself this excess of iron is avoided or is afforded by the arrangement of the mass of iron of the main magnet core. Further, in the "tripolar" electro-magnets, common to the Gramme and other machines, when the separate cores are each devoted to its circuit [and consequent as well upon what has just been stated] there can be used comparatively much lighter electro-magnets with the same armature, in small machines, without danger of sparking; because, instead of need of shifting the brushes around the commutator, *the point of greatest concentration of magnetic field in the pole pieces is made to shift relatively to the armature* by the increase of magnetism of the main circuit core. Another advantage of the separate system is that fewer turns of main-magnet wire, and consequently less resistance, are needed in the main circuit. Whilst only few lamps are alight, the shunt magnets are partly muffled by the inert mass of the main magnet cores; when more lights are switched in and more current passes around the main coils, these cores become somewhat abruptly converted from (so to say) keepers to the shunt-magnets into magnets, and their rise of magnetism is at nearer saturation somewhat rapid. I think Dr. Ernst Richter has obtained similarly better results with separately wound machines, although the machines he tested were not in the best proportion, as far as may be judged by his figures.

Mr. Macgregor adverts to my earlier endeavours to make a machine self-regulating in series. This has long been a hobby of mine, but I have only recently attained practical success.

My object has been to charge several batteries of accumulators at different stations in series, and to be independent of all switches, which do not always perform their duty.—Yours, &c.,

PAGET HIGGS.

MEASURING THE EARTH-RESISTANCE OF LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On various occasions much interesting and valuable information has appeared in the columns of *The Electrician* on the subject of the testing of lightning conductors; but there is one point which, to the best of my recollection, has not been referred to—viz., the correction or elimination of the effects of the current due to the difference of potential of the earth plates.

For example, suppose the conductor has a copper earth-plate, and the earth-wire from the Wheatstone bridge is fastened to the iron water or gas pipes, then owing to iron being electro-positive to copper—on completing the circuit—a current will flow from the iron, through the ground to the copper, and thence through the leads-bridge, &c., back to the iron "earth."

If a galvanometer be placed in this circuit the unsteadiness of the deflection will not only show the presence of this current, but also the variation in its strength due to polarisation of the earth plates.

Hence, the way in which we connect up the testing battery becomes of importance. With the earth plates above mentioned, we should, by joining the battery so as to put copper to earth (*i.e.*, iron water pipe) and zinc to line and conductor, reinforce the E.M.F. of what I may be allowed to call the earth battery; while by reversing the testing battery, so as to put copper to conductor and zinc to earth, we should oppose, and, in fact, overcome this counter E.M.F. of the earth plates.

In short, in the first position the available E.M.F. would be the sum, and in the second the difference of the testing and earth batteries respectively.

Figs. 1 and 2 will make this apparent, where the *thin* arrows show the direction of the current due to earth plates, and the *thick* arrows that due to the testing battery.

In the series of measurements tabulated below—the ordinary form of Post Office bridge, a Wheatstone-Daniel cell, and a Thomson reflecting galvanometer of low resistance being employed—I obtained the following values:—

	I.	II.	III.
With iron water pipes for testing "earth":—	Ohms.	Ohms.	Ohms.
Copper to earth	31	46	24
Zn to earth	97	50	35
With iron gas pipes for testing "earth":—			
Copper to earth	35	44	22
Zn to earth	100	44	36
Resistance of water and gas main:—			
Copper to gas	2·54	2·54	1·6
Zn to gas	1·76	1·76	1·3

I. Brass rod driven deep into moist earth, to represent conductor and its earth plate.
II. Iron rod substituted for brass one in I.
III. Actual lightning conductor of copper rope, several feet being buried in moist earth, but no plate.

Of course the reason for taking three sets of measurements, viz., firstly, of the conductor with water main for earth; secondly, with gas main for earth; and, lastly, of the water and gas mains together, is to obtain the actual resistance in ohms to earth of the conductor.

FIG 1

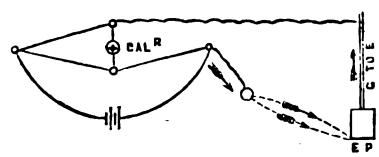
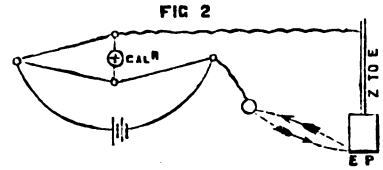


FIG 2



But the object of my writing is not to deal with this part of the subject, but to inquire what value are we to take as correct in such a case as Example I. Where we get with copper to earth 31 ohms, and with zinc 97 ohms, would it be safe for practical purposes to take the mean?

The case is somewhat analogous to a telegraph line traversed by an earth current, and for testing the resistance of such a line or cable Mr. Kempe, in his "Handbook of Electrical Testing," gives an elaborate formula, adding, "that several modifications of this formula have been suggested, but are only applicable under certain conditions (not stated), and as the formula is seldom required it is better to use the one given." But I venture to suggest that the data given above show that in testing lightning conductors some such formula will be in constant requisition, and my object is to ask Mr. Kempe or some other reader of "ours" to kindly favour me with a simple and yet approximately correct formula for calculating the true resistance from the observed.

I am aware of the method mentioned by Mr. Kempe of opposing this E.M.F. of the earth plates by interposing a standard Daniell cell with large plates shunted down till no current flows in the circuit in its normal state; but although I have obtained fairly good results with it, it is, to say the least, somewhat cumbersome when employed away from home Besides, the change produced by polarisation of the earth plates renders necessary a constant alteration of the "shunt." Apologising for the length of my letter—Yours, &c,

W. H. WHITEHOUSE.

Midland Institute, Birmingham.

P.S.—Since writing above I find that your correspondent "A. J.," page 109, Vol. XI., incidently refers to this subject,

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and states that galvanometer must be balanced to "false zero." Would he kindly explain the method?

INDUCTION IN TELEPHONE CIRCUITS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your last issue an article entitled "Induction in Telephone Circuits," by Mr. F. W. Neale, of Stoke-on-Trent, in which the writer details the results of experiments made by him with induction coils placed mid-way in telephonic wires, with the object of neutralising the effects of induction to and from neighbouring conductors.

I am sorry to disturb the gratification that Mr. Neale probably experiences in having brought his two years' labour to a successful issue, and I am far from questioning the perfect independence of his invention, for I know how liable are two minds, when working with the same end in view, to coincide in their conclusions; but if he will refer to my patent, No. 4,428, of 1881, he will find the invention described and figured substantially as in his article. In that patent three plans are set forth for neutralising the effects of induction in parallel wires. Of these, Mr. Neale's is the second, and is marked Fig. 5 on the sheet of engravings. Even the methods he describes of ringing through and past the translator, although not included in the patent, have all been anticipated. The patent is now the property of the Electromotive Force Company (Limited), of 6, Hanover-street, Glasgow, with whom Nr. Neale will doubtless have to arrange if he wishes to continue the use of the apparatus.—Yours, &c.,

A. R. BENNETT.

National Telephone Company (Limited),
8A, Royal Exchange, Glasgow.
December 1st, 1884.

PAYING FOR SPECIFICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I wish to trespass on your valuable space to draw attention to the latest phase of the confidence trick as applied to electric lighting.

One of the most recently-established firms of electrical engineers and consulting electricians are asking, under the powers vested in them by the Grosvenor Gallery proprietors, three guineas for their specification, which three guineas are not returnable. We believe that people asking for estimates for electric lighting should be prepared to pay from one guinea to twenty guineas, according to the amount of trouble involved in the estimate, but this newly-formed firm seems to think that other electrical engineers are in such a scramble for work that they will in the aggregate part with a nice 100 guineas for the pleasure of competing for a new job.

I have declined to be a party to this arrangement, and I trust all other electrical engineers will join us in our decision.—Yours, &c.,

ENGINEER.

[We should be glad to know if the general feeling of electric light engineers is against payment for specifications, and willingly open our columns for a discussion of this question.—ED. *E.*]

A GENERAL INDEX.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A correspondent in your issue of November 22nd makes suggestions for further facilities for reference to back volumes of *The Electrician*. I would add a suggestion referring to back numbers of the current volumes.

Until the volume is completed by the appearance of the index with the final number, a reader wishing to refer back to any article is obliged to turn to the middle of each number for the table of contents, unless he has made special notes for himself on the outer sheet.

I would suggest that the headings of the principal contents should be placed in three or four lines at the top of the outer sheet, above the title of the paper (as, for example, Mr. Proctor now does in *Knowledge*, with so much advantage to his readers). This would enable a reader rapidly to pick out any desired article, without opening and turning over many numbers in his search.

Failing this, the removal of the "Contents" to the first page of "Notes" might be an advantage, though as it would require the reader to first take off the advertisement sheets, the facilities for rapid reference would be reduced.—Yours, &c.,

SUBSCRIBER.

December 3rd, 1884.

"DIE ELEKTRISCHE BELEUCHTUNG."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. J. Springer, publisher, Berlin, has sent you a copy for review of my recent work on electric lighting, and I beg to draw your attention to a mistake which has escaped correction. At page 41, line eight from bottom, instead of "Gleich" read *Klein im vergleich zu.*

In the event of your reviewing my work, will you have the kindness to point out the mistake to the reviewer, and to make the correction?—Yours, &c.,

PROFESSOR DOCTOR E. HAGEN.

Dresden, Altstadt, 27, Lindenau-strasse, Nov. 24, 1884.

[Our notice of this book will be found on p. 571, Vol. XIII. —ED. *E.*

THE LIGHTING AT THE VICTORIA STATION.

One of the finest metropolitan installations is now in working order. There has been no public announcement of its opening, but as descriptions of it have commenced in contemporary publications we do not feel bound to the silence hitherto kept, in deference to wishes conveyed to us some time ago when inquiring into details of the installation for publication. The arrangements for lighting the Victoria Station by means of electricity were settled with the Swan Company, and carried out by Messrs. Crompton and Co. The work, of course, has been under the United Edison and Swan Company, since the amalgamation. We have often referred to examples of Messrs. Crompton's installations, but we do not think that any of their work contains greater proof than this Victoria installation of the ability of the firm to carry out in the best possible manner the work entrusted to their charge.

An electric light installation consists of three parts. The first supplying the motive power, in this case steam; the second generating the electrical energy; and the third distributing and utilising that energy. Taking the Victoria installation in this order, the steam required for the engines is generated in three boilers of the locomotive type, illustrated below. These large locomotive boilers were designed at Mr. Crompton's request for this special purpose by Mr. W. H. Maw, C.E., who designed the boilers at the *Daily Telegraph* offices, and who has probably had more experience on this class of boiler than any other engineer in England. The objects of the design were to get into a small space of 20ft., over all length, by 5ft. wide and 8ft. high, a boiler capable of generating steam sufficient for 200 horse-power with great ease and economy. This these boilers have certainly succeeded in doing. Repeated trials have shown that they evaporate from 9·06 to 9·08 of water per lb. of Welsh coal, and this without any sensible priming. The power of each boiler is fully 230 horse-power—that is to say, they are capable of evaporating about 90 cubic feet of water per hour with the natural draught. Steam can be got up in about 35 miuutes, if the power is suddenly called for The whole of the fittings have been very carefully thought out by Mr. Maw; the water gauges have Dewrance's patent asbestos packed cocks, and they are in duplicate, and can be worked from either side by levers extending across the front of the boiler. This is a great convenience in the case of the

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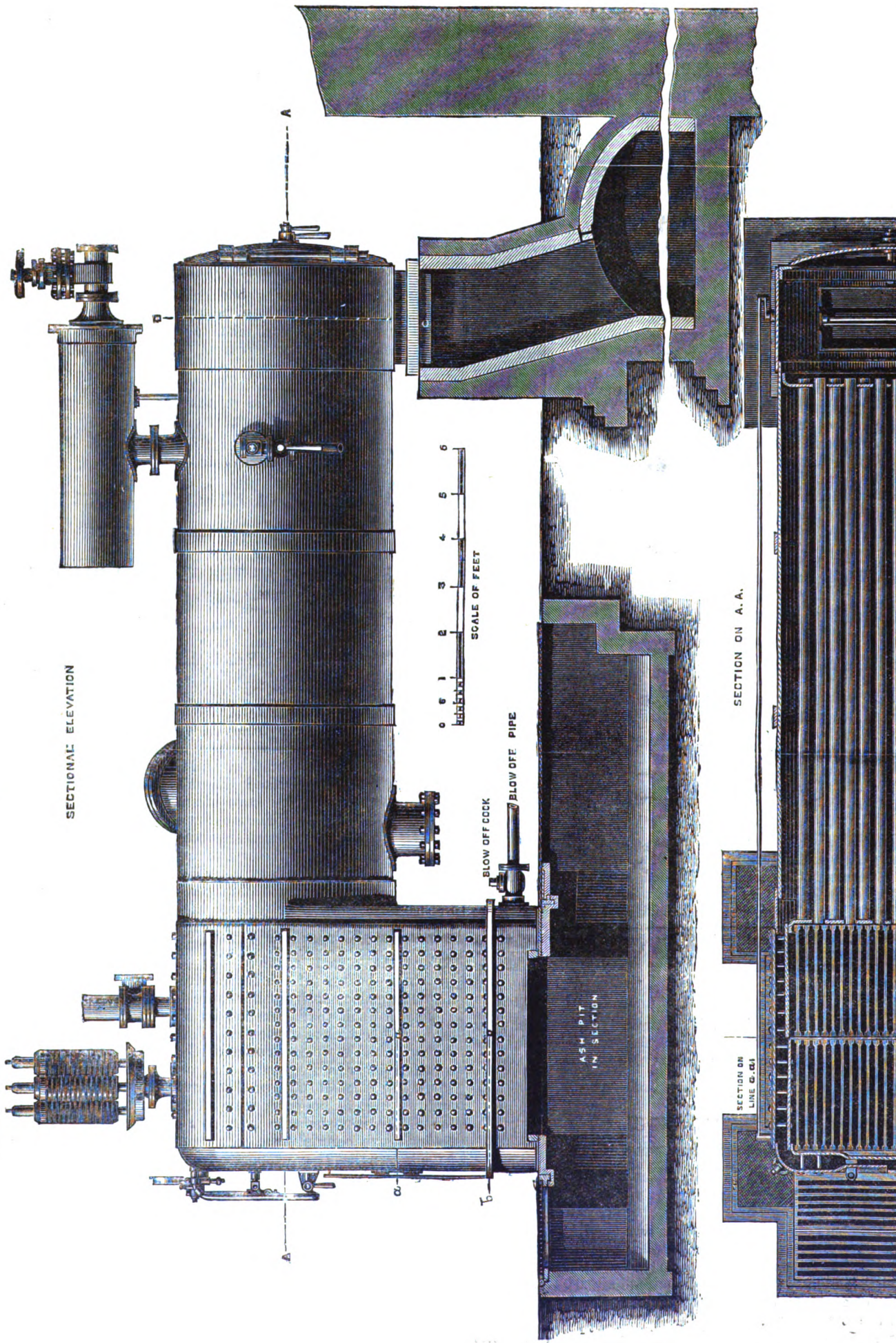
SECTIONAL ELEVATION
SCALE OF FEET
0 6 1 2 3 4 5 6
BLOW OFF COCK
BLOW OFF PIPE
ASH PIT IN SECTION
SECTION ON A. A.
SECTION ON LINE C. C.

LOCO. BOILER AT THE VICTORIA INSTALLATION.

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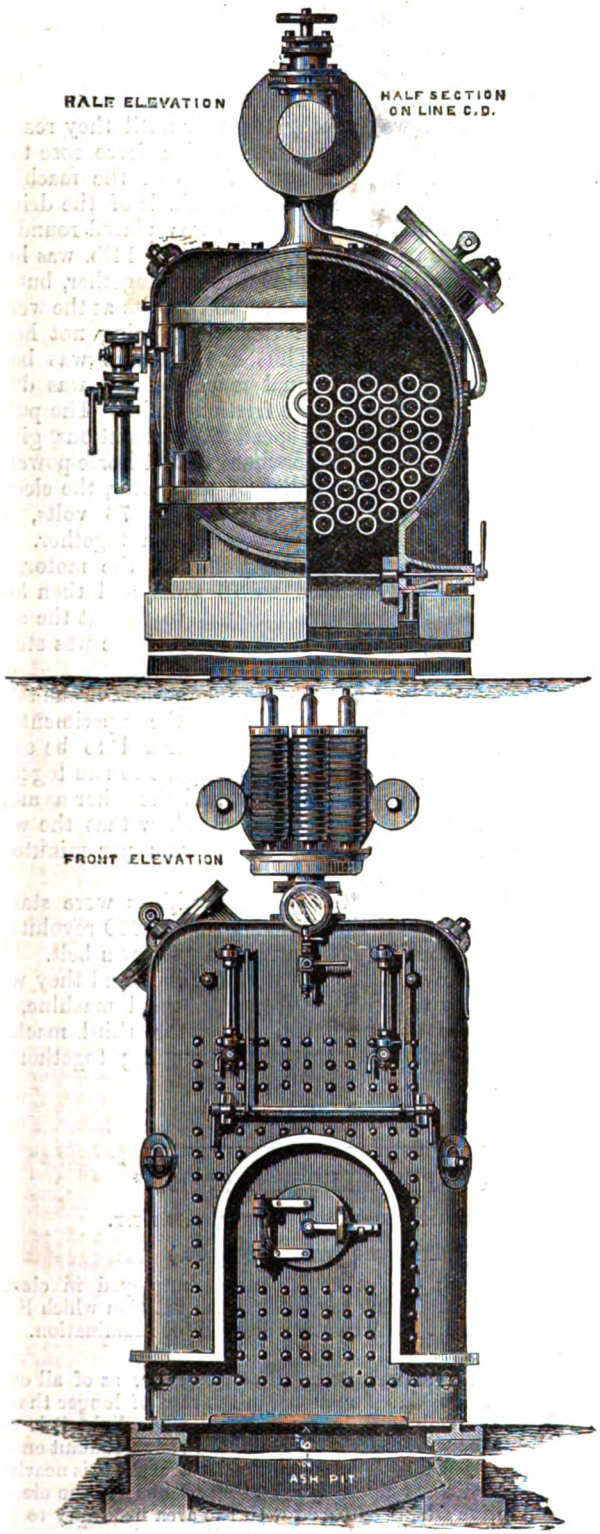
gauge glass breaking. The lever safety valves, back-pressure valves, and many other of the fittings are of special design, and not being a regular article of manufacture, had to be made specially by Messrs. Crompton themselves. The draught is supplied by an octagonal chimney, 5ft. internal diameter, 129ft. high. This gives ample natural draught for the present requirements, but if at a later period the boilers are required to supply steam for additional engines, they have been so



Boiler at the Victoria Installation.

arranged that the Willans patent fan draught can be applied to them, which will increase their evaporating power sufficiently to make them equal to nearly double their present output of power. The makers are Messrs. Hick and Hargreaves, of Boulton, and the material of the plates is mild steel specially tested. Strips were cut from every plate, and subjected to very severe tests, and the test strips have in all cases been preserved. Altogether we may consider the boilers as very favourable examples of the most recent practice in this particular line. The following details will be interesting to all engineers :—

DETAILS OF BOILERS.

	ft.	in.
Extreme length of each boiler	20	0
External diameter of barrel	4	9
External width of fire-box	4	11
Internal width of fire-box	4	1
Internal length of fire-box	5	1
Grate area	21·5 sq. ft.	

Copper Fire-box :	ft.	in.
Height of fire-box above level of grate	5	6
Centre of barrel above floor level	5	7
Centre of fire door above floor level	3	3

74 wrought-iron tubes No. 8 B.W.G., 3½in. external diameter, 11ft. 11in. between plates.

Heating surface in tubes	732	sq. ft
,, ,, fire-box	111	,,
Total	843	,,
Area through tubes	4	,,

Safety valves :—One group of Cowburn's patent dead weight safety valves loaded to 143lb. per yard. Two 2½in. lever safety valves loaded to 140lb. per yard.

Steam Collector :	ft.	in.
External diameter	1	6
Length of same over all	5	0
Connecting pipe diameter	0	7
Main steam pipe	0	6
Branches from each boiler	0	4

With Dennis straight through valve :—Down take, 2ft. by 3ft. ; underground flue, 4ft. wide by 6ft. high.

THE ALTERNATE-CURRENT MACHINE AS A MOTOR.*

BY PROFESSOR W. GRYLLS ADAMS, F.R.S., PRESIDENT.

In July last, whilst engaged in testing the efficiency of alternate-current magneto machines at the South Foreland, for the Elder Brethren of the Trinity House, it was suggested to me by Dr. Hopkinson to try the experiment, which was shown by him to be possible in his lecture before the Institution of Civil Engineers last year, viz., the running of two alternate-current magneto machines together, without clutching them on the same axis, in order to supply current to an external circuit.

The machines now being tested at the South Foreland are three De Meritens alternate-current magneto machines of the largest size made by him, having 60 permanent magnets, arranged in 5 rings of 12 magnets and 24 coils on each ring of the revolving armature. Each coil consists of four layers of wire, and is 27 millimetres deep and about 100 millimetres wide. The 120 coils when arranged in parallel circuit for lighthouse work have a resistance of about one-twentieth of an ohm. The internal resistances of the three machines are ·044 ohm, ·049 ohm, and ·056 ohm.

The five rings of coils on each of the machines are connected in parallel circuit when all the brushes are down, but the collectors and brushes on each machine are made in three sections, so that it is possible to employ one ring only of magnets and coils, or two rings only, or the remaining three rings, or the whole five rings together, by bringing the respective brushes in contact with their own collectors, which are insulated from one another by ebonite rings or flanges on the ebonite axis which insulates the collectors from the axis of the machine. The diameter of the armature carrying the revolving coils is 2ft. 6in., or 760 millimetres, and the driving pulley is about 16in., or 400 millimetres, in diameter.

When revolving at the normal speed, 600 revolutions per minute, the magneto machines have been found to work with very great steadiness and with great efficiency. The electro-

* Paper read before the Society of Telegraph Engineers and Electricians on Thursday, Nov. 13th, 1884.

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motive force is about 75 volts and $\frac{2\pi\gamma}{T} = \cdot 3$ ohm nearly. When running with the circuit open, a very considerable amount of work is spent on the friction and internal work within the machine, but on closing the circuit this is greatly diminished, and the output of the machines, or the electrical energy in the external circuit, exceeds the *additional* work done to produce it. Thus a single machine absorbs 4·2 horse-power when running at 600 revolutions with the circuit open, yet only absorbs 10·4 horse-power with the circuit closed with one arc lamp in circuit, when it yields in electrical energy 6,000 watts, or 8 horse-power, in the external circuit. These watts are obtained by multiplying the average electromotive force, as given by Cardew's voltmeter, by the average current as given by Siemens' electro-dynamometer. This product will give a result which, according to Dr. J. Hopkinson's calculations, is above the true value.

The electromotive force was also determined by a quadrant electrometer, by joining the needle to one pair of quadrants, when the expression for the electromotive force becomes $(V - V_1)^2 = E^2 = \frac{2d}{k}$, where d is the deflection, and k the constant of the electrometer.

The method of determining the work done in the arc by joining the pairs of quadrants of the electrometer to the two ends of a known resistance placed in the circuit, according to the formula

$$d_1 = k\,(V_1 - V_2)\left(V - \frac{V_1 + V_2}{2}\right) = k\,C\,r\left(V - \frac{V_1 + V_2}{2}\right),$$

was also tried, but the introduction of even a small resistance, r, materially altered the electromotive force and also the current in the circuit, and the method was not sufficiently sensitive. Thus, when the deflection by the first method, or $\frac{k}{2}(V - V_1)^2$, was 120 divisions of the scale for an electromotive force of 57 volts, the deflection by the second method was only about 30 divisions when r was about one-fifteenth of an ohm. The addition of this resistance considerably increased the electromotive force, and diminished the current in the circuit.

At the South Foreland the leads from the machines to the arc lamps in the experimental tower have a resistance of ·066 of an ohm, and when two machines were clutched together and working in series, so as to supply two arcs in series, the yield of electrical energy per second was about 10,200 watts in the external circuit; whereas, when working in parallel circuits through the same leads to one arc lamp, the yield was only about 8,600 watts in the external circuit.

To test whether alternate-current machines would work in harmony without being rigidly made fast on the same axis, two machines which are usually clutched together were set running, being joined in parallel circuit, and when they had attained their usual speed of about 600 revolutions a minute they were unclutched, and each was driven only by its own belt. The two machines continued to run together very steadily, mutually governing one another; the electromotive force remained steady at 75 volts on open circuit, the same as the electromotive force of one of the machines which had been previously tested.

The machines were not quite equal in efficiency, for before this experiment one of the single machines had given a current of 135 amperes, and the other 165 amperes, with electromotive force of 37 volts, at the normal speed of 600 revolutions; now on closing the circuit from the two machines through the arc, the electromotive force became steady at 40 volts, and there was a current of 221 amperes, giving 8,800 watts in the external circuit, and the machines continued to run as steadily as if they had been clutched.

The lamp was now put out of the circuit and the machines short circuited upon one another, without the slightest danger to the machines, owing to their high coefficient of self-induction. The belt was then thrown off one machine, when it continued to run at the same uniform speed, being driven as a motor by the electric current from the other single machine, and the electromotive force was equal to the electromotive force of the machine on open circuit.

An attempt was now made to introduce an arc into the circuit, but the motor immediately began to lose its speed and the arc became fitful with long beats, as in two musical instruments getting out of harmony, the beats increasing as the speed fell and the machine stopped.

A third machine similar to the others, but not placed on the same axis and having no mechanical connection with them, was also driven as a motor by one of the other two machines.

These experiments were repeated, and some other interesting experiments made, on October 18th, when Dr. J. Hopkinson went with me to the South Foreland.

Two machines were started together, but independently, each being driven by its own belt, and they increased their speed in harmony, always going together until they reached their normal speed, when the electromotive force rose to 80 volts. The belt was now thrown off one of the machines, when the electromotive force at the terminals of the driving machine remained at 80 volts. A strap was placed round the pulley of the motor machine, and a weight of 14lb. was hung on the strap; the machines continued to run together, but the electromotive force oscillated from 80 to 78 volts as the weight rose and fell with the pull on the strap, being not heavy enough to give a steady pull. Thus one machine was being driven as a motor by another equal machine, and was doing work which was measured by the friction brake. The pulley was 16in. in diameter, and the speed 600 revolutions, giving 35,200 foot-pounds per minute, or more than 1 horse-power.

On putting on 28lb. on the pulley of the motor, the electromotive force was reduced from 80 volts to 78 volts, and remained steady, and the machines still ran together. On putting 42lb. on the brake on the pulley of the motor, the electromotive force was reduced to 76 volts, and then 56lb. was put on, when the motor continued to run at the same rate as the generator, and the electromotive force was steady at 74 volts.

On account of the heating of the extemporised brake strap, it was not thought advisable to continue the experiments by adding heavier weights, although there seemed to be every probability that the machines would continue to run together at the same speed, the one as generator and the other as motor and doing work. The above experiments show that the work done on the brake was 140,000 foot-pounds per minute, or more than 4 horse-power.

In another experiment the three machines were started together, and run up to their usual speed of 600 revolutions per minute, each machine being driven by its own belt. The belts were then thrown off two of the machines, and they were driven as motors by the current from the third machine, the electromotive force at the terminals of the third machine being the same as when the three were running together in parallel circuit.

(TO BE CONTINUED.)

ON THE ELECTRIC LIGHT.*

BY ALFRED RICHARD SENNETT, A.M.I.C.E.

(CONTINUED FROM PAGE 60.)

Before considering the other apparatus employed in electric lighting, it will be interesting to glance at the relation which lighting by the electric arc bears to other methods of illumination. As regards—

Heating.—The thermal effects of the electric arc, as of all other sources of light, are due far more to the rays of longer than to those of shorter wave-length, but with the electric light it is very pronounced. The ratio of the invisible to the visible radiant energy of the sun is about as 2 to 1, whilst in the electric arc it is nearly as 8 to 1 (Tyndall). The area of the incandescent body in the electric arc is so diminutive when compared with the area necessary to produce an equal amount of light from gas, oil, or other source, that although the temperature of the former is so much more elevated than that of the latter, yet the rise in the temperature of the surrounding air, due to convection, is infinitesimal when compared with that due to gas and other sources of illumination producing a light of equal power. In order to illustrate this, the electric arc may be viewed as an ordinary domestic fire, from which nearly

* Paper read at a Supplementary Meeting of the Institution of Civil Engineers.

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the whole of the air deriving its heat by convection passes away by the chimney, since in the arc the heating by convection may be nearly neglected. The remaining energy is spent in communicating oscillatory movements to the luminiferous ether. The waves thus produced do not heat the air in their passage through it, but are converted into heat only when they traverse an absorbent medium, or impinge upon the walls, ceiling, floor, &c., of the apartment, and it is from these latter that the air derives its increase of temperature. The heating effect, then, of the electric light in an open space may be said to be *nil*. In a confined space, a rise in the temperature of the air will take place proportional to the energy expended in the arc. Since, however, the amount of light produced per unit of heat so expended is so much greater than by other means, the air will receive a much smaller increment of heat by this than by other methods of illumination. For the purpose of comparison imagine a chamber, say 50ft. square by 20ft. high, from which no loss of heat can take place, to be illuminated for ten hours by a light equal to that given by 4,000 standard candles, the light being produced respectively by the electric arc, by incandescent electric lamps, by gas, and by candles. At the end of the ten hours the temperature of the atmosphere of the chamber would be raised :—

	Centigrade. °	Fahrenheit. °
By the Electric Arc	0·706	1·27
By Incandescent Electric Lamps	7·0	12·6
By Gas	78·4	141·0
By Candles	190·0	342·0

In other words if, at the commencement of the ten hours, the atmosphere of the chamber had been at the ordinary temperature (16° Centigrade, or 60°·9 Fahrenheit), then at the expiration of the ten hours it would have been raised :—

	Cent. °	Fahr. °	Cent. °	Fahr. °
By the Electric Arc from	16 or	60·9 to	16·7 or	62·1
By Incandescent Electric Lamps	16 ,,	60·9 ,,	23 ,,	72·9
By Gas	16 ,,	60·9 ,,	98·4 ,,	201·8
By Candles	16 ,,	60·9 ,,	206 ,,	402·8

Secondly, as regards the products of combustion :—

Vitiation of the Atmosphere, due to various methods of Illumination.—Compared with other methods of illumination the products of combustion from the electric arc are very small. In order to obtain a comparative review of the amount of defedation consequent upon the employment of the more important illuminants, reference will be made to the before-mentioned 4,000 candle power and to the hypothetical chamber. The amount of carbon consumed during the ten hours would be about 1,750 grains, and this, combining with the oxygen of the atmosphere, would yield 6,413 grains of carbonic anhydride (CO_2)=7·4 cubic feet (barometer 30in). There would also be a small amount of nitrous acid as nitrites, probably about 771-5 grains of nitrous anhydride.

The amount of these products will depend upon the position of the arc, whether it is confined or if the air is permitted to play freely around the poles, also whether the carbons be placed horizontally or vertically; if placed horizontally the amount of the products will be much greater. There will also be a slight trace of sulphur, as the author has found this in all the well-known carbons ; it will probably be given off as sulphurous anhydride (SO_2). In order to facilitate comparison, the author has drawn up the following table, showing the carbonic anhydride, &c., produced per hour from an equal amount of light derived from the sources mentioned :—

PRODUCTS OF COMBUSTION FROM VARIOUS ILLUMINANTS.

—	1 CO_2.	2 N_2O_4.	3 S.	4 H_2SO_4.	5 H_2O.	Remarks.
	Grains.	Grains.	Grains.	Grains.	Grains.	
Electric arc	6,413	8	trace	...	none	Traces of cyanogen.
Gas No. 1..	852,929 =122lb.	trace	333*	1,019	286,848 =41lb.	Ordinary burner. Average gas
,, No. 2..	339,889 =48½lb.	trace	125*	382	107,568 =15·3lb.	Siemens' burner.
Paraffin oil.	573,040 =73lb.	none	trace	trace	2,683,000 =383lb.	...
Candles No. 1....	1,410,860 =201·5lb.	none	none	none	5,760,000 =823lb.	Sperm.
Candles No. 2....	1,141,514 =163lb.	none	none	none	6,336,000 =905lb.	Paraffin.

* Combines with O to form SO_2, and this, combining with O and H_2O, forms H_2SO_4.

It will be observed that no absolute value can be given to express the relation between the electric arc and other methods of illumination as regards their effect upon the purity of the atmosphere, since the efficiency of the arc (in respect of illumination) varies with the amount of electrical energy passing between the electrodes ; whilst the amount of light obtained from the combustion of a given volume of gas depends upon its quality, upon the burner or manner in which the chemical combination is accomplished, and upon the temperature at which the chemical combination is effected. With regard to oil and candles, doubtless the effect of concentration of heat in varying the propertion of luminous to obscure radiation will hold good in these cases also ; for although a given weight of paraffin or stearine can only potentiate a definite amount of energy, there are several forms in which this energy may be taken from it.

Referring again to the hypothetical chamber, it would have been necessary, in order to reduce the amount of defedation of the air as regards CO_2 to the standard of that of the air of a manufacturing town, to have changed the whole of the air in the chamber during the ten hours, as given in the second column. The first column showing the relative amounts of CO_2.

	Relative amounts of CO_2.		Times.
For the electric light	1	.....	3¼
,, gas (No. 1 in table) ordinary burner and average gas	133	.....	500
,, gas (No. 2 in table) Siemens' burner..	53	.....	200
,, paraffin oil	80	.....	300
,, candles (No. 1 in table) sperm	220	.....	830
,, candles (No. 2 in table) paraffin	178	.....	670

Actinic Power of the Electric Arc.—The spectrum of the electric arc is very long, due to prolongation both at the infra red, and ultra violet ends, but its length varies with the length of arc. The spectrum of the incandescent electric light is similar to that of candles, &c. ; but it varies greatly with the temperature to which the filament is raised, the proportion of luminous to obscure rays being in the arc about 1 to 9 (Tyndall 50 groves), in gas 1 to 24, in white hot platinum wire 1 to 23.

The actinic effect of the electric arc depends on three factors, one of which is constant and the other two variable. The constant factor depends on the current, since it varies with the area of the crater ; the other variables depend on the kind of carbon employed for the electrodes and upon the length of the arc.

The author thinks it advisable to point out the conditions which he has found favourable to the development of actinic action on a given surface.

First, a very long arc should be employed.

Secondly, a line normal to the plane of the specimen should form an angle of from 30° to 50° with the axis of the carbons, if these are placed vertically and the axis of one carbon is coincident with the axis of the other. He has found it more convenient, however, in many cases to arrange the carbons as in military and naval lighting, by which the rays of greater refrangibility proceeding directly from the crater are utilised. The observance of these conditions is obviously of great importance, when it is required to obtain the maximum speed from a given arc in the printing of photographic transfers, &c. Upon plotting a number of results it was found that the curve of actinic effect was practically coincident (especially for moderate powers) with that of illuminating power.

Penetrative Power of the Electric Arc.—There appears to be a marked distinction between the quantity and intensity of a light. Just as by increasing the velocity of the armature of a dynamo-electrical machine an increase occurs in the quantity and (to use an obsolete expression) the intensity of the current, so in augmenting the temperature of an incandescent body both the quantity and the intensity of the light increase. An analogy may be drawn from a musical sound, a vibrating string for example. In a musical sound the timbre or character of the sound is dependent upon the character and number of sounds of different and shorter wave-length which are combined with the fundamental sound, whilst the character of a light is dependent upon the character and number of rays of different and shorter wave-length combined with that of the principle wave-length or fundamental light. In the former, by striking the string with varied force and in a different manner the proportion of these sounds of various wave-length to the fundamental wave-length may be altered, and with it the character of the sound produced. So, by increasing the temperature of an incandescent body, the proportion which the rays of various and shorter wave-length bear to the fundamental wave-length is altered, and with it the character of the light. That is to say, while the amplitude of original vibrations is increased, new ones of shorter wave-length are produced, and thus the light changes in character and becomes more intense. But does this increase in intensity signify increase in penetrative power ? or rather, is the amplification in the power of penetration

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due to increased power on the part of the slower vibrations, or to the introduction of the new and more rapid ones? This will depend upon the character of the obscuring medium; for it must be remembered that the more rapid the vibrations, the more refrangible are the rays they produce, and hence it may be that one set of vibrations or character of light may be suitable for traversing a dry obscuring medium, such as smoke, and another series may be more adapted to the permeation of a humid medium, a fog or mist for example.

In a damp obscuring medium, such as fog, the rays of shorter wave-length have the greater penetrative power. One method of observing this is to mount an eminence and look along a straight road lighted by gas or electric lamps. It will be observed that each successive light farther from the observer has a more yellow, and in the remote ones a more ruddy, tinge than the preceding ones, and that the farthest light will be of a decided red as compared with the nearest. The great change in colour in the rising moon on misty evenings may be cited as another example. These facts go to show that the beacon fires employed in olden times were well adapted to fulfil their requirements, and also that for light-house illumination and other positions where penetrability is the desideratum, very strong currents producing large masses of heated pole, a short arc, and a small difference of potential between the poles (say 60 volts), should be employed.

Distribution of Light from the Electric Arc.—As in almost every source of illumination, the light produced by the electric arc is

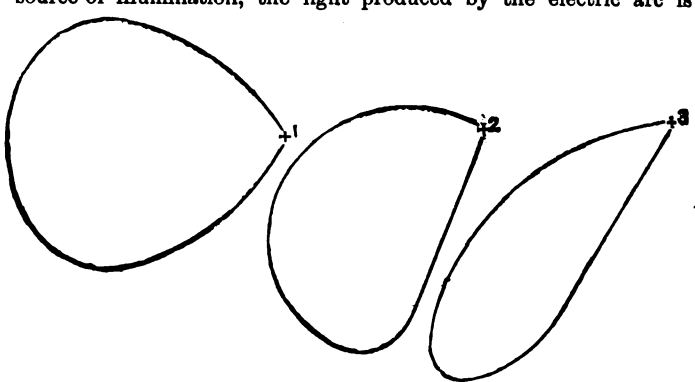

Fig. 7.

not emitted uniformly in all directions, its amount, colour, and distribution depending upon several conditions. The amount depends on the electrical energy in the arc, the length of arc, and the chemical composition of the electrodes; the colour on the length of arc, the character of current employed, and the composition and density of the carbons; the distribution on the length of arc, the character of the current, and on the carbons themselves. The annexed diagram (Fig. 7), show the distribution of light from various arcs: 1, when an alternating current is used; 2, an arc of moderate size produced by a uni-directional current; 3, a short arc and small uni-directional current.

For general illnmination and industrial purposes the positive electrode is usually placed above the negative, its axis being vertical and forming a prolongation of the axis of the negative; but for special purposes it is sometimes advantageous otherwise to dispose the electrodes. In search lights, for example, the upper carbon is generally placed in the rear of the lower, so as to expose the crater toward the front. For lighting with vertical carbons, the author prefers to employ an upper carbon of about 3 or 4 millimetres greater diameter than the lower.

(TO BE CONTINUED.)

LEGAL.

Important Decision as to Rating Telephones.

THE LANCASHIRE AND CHESHIRE TELEPHONIC EXCHANGE COMPANY (APPELLANTS) AND THE OVERSEERS OF THE POOR OF THE TOWNSHIP OF MANCHESTER (RESPONDENTS).

(Before the MASTER of the ROLLS and Lord Justice LINDLEY.)

This was an appeal from the judgment of Mr. Justice Mathew and Mr. Justice Day, in the Divisional Court of Queen's Bench, on the 3rd July, 1884, on a case stated to them, the facts being these:—

The Lancashire and Cheshire Telephonic Exchange Company were incorporated under the Companies Acts on the 21st May, 1881, for the establishment and maintenance of a telephonic exchange by means of which any one subscribing to the exchange could communicate privately by telephone with any other subscriber, and for the supply and erection generally of wires and telephonic apparatus not in connection with the telephonic exchange, for the private use of firms and individuals paying a rent for the same. The company acquired by purchase the local telephonic business of Messrs. David Moseley and Sons and the Edison Telephonic Company, and for the purpose of their undertaking laid wires, some underground and some overhead, which latter were supported by poles and standards and other attachments to the houses, the company entering into an agreement with the owners, by which they paid a nominal rent for leave to make the attachments, and undertook to remove them when required by notice so to do. In June, 1883, the respondents, the overseers of the poor for Manchester, made an assessment rating the company as occupiers of their offices in Falconer-street, Manchester, and of land, telephone posts, and wires in the township, at a gross rental of £2,400, and a rateable value of £2,000. The company admitted liability with respect to their land and premises, but not as to the wires. On the special case it was argued on behalf of the company that the wires and supports did not create such an occupancy by the company as to be rateable; while for the overseers it was contended that, following the decision in the Salford case (Exch. 11), there was such an occupancy as to be rateable under the statute of Elizabeth. The Divisional Court took this latter view, and decided for the rate. Against that decision the Telephone Company now appealed.

Mr. Collins, Q.C., and Mr. Webster, Q.C., appeared for the appellants; and Mr. Ambrose, Q.C., Mr. Smyley and Mr. Overend Evans for the respondents.

Mr. COLLINS, for the appellants, argued that the mere fixing of the wires to the roof of a house did not create any tenancy in the land or the premises, and distinguished the case from that of telegraph posts, because of there being no demise, but simply a license revocable by notice to affix the supports, which made an easement, but not one that was rateable. In support of this view he cited a case where mooring a barge to a wharf by license was held not to create a rateable occupancy. Referring to the case of Smith's bookstalls, which were held not to be liable, he argued the case of the wires was similar in not, from the terms of user, creating a rateable tenancy. The case of Willing's advertising boards was even more in point, for there certain things were fixed to walls, and it was held they did not create a liability. For the purposes of a rate there must be an exclusive and separate occupancy, which he maintained could not be proved, or even if it existed it could not be attributed to the Company.

Mr. AMBROSE, for the overseers, submitted that however the wires might be fixed they were in the sole and exclusive occupation of the Company, and created an occupancy by them in the premises and land underneath which supported them. The telegraph posts were rateable in consequence of the user of the land, even though that was subject to notice by the railway companies by the side of whose lines they were placed; and the fastenings of the telephone wires were in the same position. He further maintained that the sole occupancy of the wires created a rateable occupancy by the company in all that was underneath them, whether fixed or not.

The MASTER OF THE ROLLS, in giving judgment, said the real question was with regard to the spikes and saddles and brackets fixed to the houses for the purpose of carrying the wires, and it was obvious that the wires were accessories, so that the company were liable in respect of the things fixed to the house. The wires were fixed to the brickwork or to the wooden roof, and were part of so much of the roof as was necessary to support them; for, take away the rest of the roof, and you will have a certain support. They were supported by the building, which was supported by the soil, and were therefore supported by the soil, and so much of the soil as was necessary to support the wires was occupied by them. It was not like the right to hang things to something fixed to the soil for the purpose. There were things which might be the subject matter of the occupation by the persons occupying them. Who was in the occupation of the wires? They were the property of the company, the exclusive property, and used exclusively by them as between the company and the owners of the houses, solely for the benefit of the company and not for the benefit of the owners. It seemed that the company was in occupation of every part of the house which could be made use of for the wires, and they were in occupation of what was rateable. The attachments had become part of the realty by the manner in which they were fixed to it. It never was intended that any copartnery should exist, or that these things should ever belong to the owner of the house, the exclusive ownership and right to deal with them being in the company. The case was like that of the telegraph posts, and there was no reason why the rule laid down in the Salford case should not govern it. The appeal must be diemissed with costs.

Lord Justice LINDLEY concurred, and the appeal was accordingly dismissed.

Mr. COLLINS gave notice of appeal to the House of Lords.

COMPANIES' MEETINGS & REPORTS.

The Gulcher Electric Light and Power Company (Limited).

The second ordinary general meeting of this Company was held at the Offices of the Company, 4, Coleman-street, Bank, on the 4th inst. Mr. Daniel de Castro presided.

The SECRETARY (Mr. Russell Day) read the minutes of the last meeting, which were confirmed, and the notice convening the present meeting.

The CHAIRMAN said the resolution he had to propose was in rather an unusual form. It was as follows:—"That the report and accounts of the Directors as presented to the members at this meeting be adopted and approved; and that the sum of £162 11s. 2d., part of the £1,776 18s. 10d. standing on the 30th September, 1884, to the credit of the trade and other

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debts, and the sums of £880 12s. 6d., £125, and £85 11s. 7d., part of the sum of £1,963 19s. 1d. respectively standing in the books of the Company to the credit of Directors' fees, Mr. H. Crookes' salary account, and W. Crookes, Esq.'s, F.R.S., loan and interest account, be treated as claims only." He then referred, in explanation of the unusual character of the resolution, to the position of the previous report and accounts, and to the opposition which he made to the passing of those accounts; and afterwards stated that he asked them now not to treat all the credits which appeared in the books of the Company as credits, but to treat some of them as claims only. On the 30th of June, 1883, the accounts showed that their capital was £168,000, their liabilities £172,000, and they had £19,000 of creditors. Their stock and plant together were less than £20,000; their trade debtors were £1,100, and their cash was £2,560. It was not until the 28th September, 1883, that the new Directors were elected, and at that date the position was a very different one indeed from that represented by that balance sheet. When they came into power Mr. Crookes was their Chairman, and with one exception, his (the speaker's) co-Directors supported Mr. Crookes. Their liabilities at that date were greater than the £19,000 mentioned. There was a bill of sale over their property for over £11,000; and the cash balance, instead of being £2,600 odd, was only £227, out of which they had to pay £170 for wages of the week on the Tuesday when they took office. When they took office the debts of the Company were twice—and a great deal more—what they were now; and the cash balance was £50. The fifth call had been made, and it had been mortgaged to the same gentleman who held a bill of sale over their property. There was £1,000 carried to the credit of the Company as a deposit on a concession sold to a Scotch Gülcher. With £57 in the bank, the bill of sale hanging over them, not a "rag" of their property that they could call their own, before the new Directors had been in office three weeks they were told by an award of an arbitrator that they were to pay £1,000 and costs within ten days. That £1,000, it appeared, had been a subject of arbitration, of which the shareholders had heard nothing. He confessed that at the time he never dreamt that they would be able to pull through the almost impossible position in which they found the Company, but the Directors were a shareholders' Board—they were all *bonâ fide* shareholders, and they represented the *bonâ fide* shareholders. They resolved to go round to the *bonâ fide* shareholders, to state candidly the position of the Company, to tell them that if they wound up it seemed to him that they would lose everything, and to ask them whether they would make any advances to give the Directors time to try and pull the Company out of the mess in which they had found it. They concealed nothing. The result was that from a number of their powerful shareholders they received unlimited support, and with the money so obtained the Company had been placed in its present position. In ascertaining the real position of the Company he received great assistance from the late secretary of the Company. He got in that manner at the origin of the Company, and the result was that within three months all the shareholders against whom he had protested "threw up the sponge." They gave up £75,000 on account —£70,000 absolutely of the purchase money, which was supposed to have gone into the pockets of poor Mr. Gülcher; and they then thought that they saw a possibility for the Company. Mr. Crookes confessed that his position was so much improved by the result of the negotiations with the promoters of the Company that he unreservedly gave up £10,000 of his shares to further reduce the liability of capital hanging over them. Mr. Gülcher and Mr. Groth responded in an equally handsome manner. Their capital, by these negotiations, had been reduced, if he remembered rightly, from £196,000 to about £90,200. This reduction was not, however, yet absolutely completed. The balance-sheet now before the shareholders—going up to the 30th September last—was a miserable affair, but it was honest. It was, too, better than it looked. At some length he pointed to the position which it disclosed. The amount at that time acutally paid into the coffers of the Company by *bonâ fide* shareholders was £54,910, and the capital of the Company was then £108,653 11s. 8d., plus two amounts of calls in arrear, bringing the capital up to £116,000 or £117,000. At the time the sixth call was made he determined that if possible there should not be another call for at least twelve months, thus giving the poorer shareholders breathing time. The richer ones assisted him, as before, and paid their calls in advance, and others took debentures secured on unpaid calls; and authority was obtained from the shareholders to raise £10,000 on debentures. On the other side they had patents—after writing off nearly £20,000—standing at £55,000, and plant and tools £5,800. They knew the value of such assets in the event of a compulsory sale. Then their convertible assets were £125, a bill; £1,447 trade debts; and cash in the bank £17 7s. Since then the arrears of calls had been gradually reducing; and before the litigation there had been received on that account £1,350, £250 on account of the debentures issued but not yet allotted; and of the trade debts they had received at the date of litigation about £1,200. That was all the result of six weeks; and against the £1,200 received on account of trade debts they had added £1,034 new assets. Their liabilties at the 30th September certainly amounted to £3,924, but of that sum the trade creditors were £1,776, and Directors' fees, salaries, loan, and interest, £1,953. In the six weeks, instead of having serious liabilities they had reduced the trade liabilities to less than £1,200; their disputed liabilities were still £1,343, and they had assets equal to their admitted liabilities, and without treating their patents or their plant as worth a snap of the finger, they had £527 to the good at the bank. An approximate balance-sheet had been made up to the 30th of November, and at that date they owed £9,950 to debenture holders, and about £106,000 to their shareholders, and they had no other debt in the world that he knew of. There was receivable upon a bill £125, £1,180 was due to them from trade debtors, and they had now at the bank £769. He had treated the patents as worth nothing, but he believed the Gülcher patents to be of great value. The stock stood at £18,000, and about one-third of it was earning income on hire. If the Company lasted over that day they had on their shelves now about £2,800 of stock, which he believed within a few days of the passing of the accounts would be earning the Company £25 a week. Therefore, £6,000 of their stock, if the Company continued, would be earning them at the rate of £2,000 a year. Their stock was appreciated by the Health Exhibition Commissioners, and he had been invited to apply for a better position in the Patents Exhibition of next year than they had hitherto occupied, and he thought of that stock they would be able to put out another £2,500, with very little expense, which would earn more than £900. There was a hope yet for the Gülcher Company. He next alluded to the legal proceedings against the Company by Mr. Crookes, Mr. Henry Crookes, and Mr. Norton. He warmly denied the allegations made by the last two gentlemen that the Company was insolvent, and strongly criticised the nature of the petition presented by both of them. Having spoken of the changes which had been made in the conduct of the business, and the economies thus effected, he stated unhesitatingly that more than half the losses of the Company had been due to the incandescent lamp department. They had, however, done all they could to make the Crookes lamp a success. It had at length been decided to bring an action against Mr. Crookes for misrepresentation. He put the case to Mr. Crookes thus:—If you had been a common grocer, and had sold me a chest of tea honestly believing it was sound, and it is discovered to be damaged, or that no tea can be made out of it, is it decent for you to refuse to return to us—even the money. But I do not ask for that. I ask for half the money, and take back your chest of tea. That was the position the Directors had taken up with Mr. Crookes, and that position he recommended them to pursue to the end. If there had been an obstacle to the success of the Company it had been the Crookes lamp.

Major COTTON seconded the motion.

A long discussion followed, and the CHAIRMAN replied *seriatim* to the questions asked. In answer to one gentleman he stated that the action against Mr. Crookes was for the return of his purchase money and the rescision of his contract on the ground of misrepresentation before entering into it, and consequential damages.

Mr. REEVES stated that he was the largest shareholder of the Company, and he moved an amendment that the accounts and report be received, but not adopted or approved, and that the meeting do stand adjourned to this day five weeks, and that a committee of the shareholders be appointed.

Mr. DAVIDSON seconded the amendment.

The CHAIRMAN, in the course of reply, and in answer to further questions, said that during the last six weeks there had been an unusual development of the inquiries as to the Company's light and of orders; and they were very much more inclined now than they were a few weeks ago to think that those inquiries might be developed into orders. He did not think that the litigation in connection with the Company would be endless, but he would say no more on that point. A five weeks' adjournment would ruin them.

He put the amendment and declared it lost.

Mr. DAVIDSON then demanded a poll.

On this demand considerable discussion followed, as to whether there were votes representing a fifth of the capital, which was necessary to support the demand.

The CHAIRMAN said that he was not going to burke an inquiry, but the capital of the Company was £22,572, and votes to represent a fifth of that amount must be held before he would grant the demand for a poll.

It was then found that with Mr. G. Monkland's proxy Mr. Davidson held sufficient voting power to demand a poll; and

The CHAIRMAN stated that the meeting would be adjourned for a week for the poll to be taken.

A letter was then handed up to the Chairman from Mr. Monkland, stating that he could not come to the meeting, and that under the circumstances he was not disposed to vote at all, adding that he had not been at the meeting, as stated, through a misapprehension by Mr. Davidson.

The CHAIRMAN on this (Mr. Davidson dissenting) ruled that there was no proper demand for a poll, which he would not grant. He afterwards put the original resolution, and declared it carried.

The Directors were afterwards re-elected; and Mr. Jackson was appointed Auditor.

A vote of thanks to the Chairman and Directors closed the meeting.

Railway and Electric Appliances Company, Limited.

An extraordinary general meeting of this Company was held on Thursday, at the Cannon-street Hotel. Colonel R. Jackson in the chair.

Mr. W. SHEPHERD (the Secretary) having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I shall endeavour to occupy as little of your time as possible in my preliminary remarks, but I shall afterwards be prepared to answer any questions that may be put by any shareholder, and to deal with any matters that may be brought before the meeting The object that the Directors have had in view in negotiating the arrangement which you are asked to confirm is to take one more important step in connection with getting the Company out of the realm of litigation which has been the bane of its career hitherto, and this compromise together with the compromise which you agreed to on the 18th April will have the effect of making a material change in the capital position of the Company. The shares which will be cancelled by the compromise which you are asked to sanction number 41,681, and the capital paid upon them has been £20,975 12s. 6d. You are asked, by the payment of £4,000 to get rid of the liability of £20,975 12s. 6d. If you agree to the proposal, the capital position of the Company will be as follows:—There will be 28,450 fully paid-up shares, and 50,051 ordinary shares,

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upon which 12s. 6d. has been paid, the share capital of the Company being £78,501 against £172,232, which it stood at before the two compromises, and the capital which would rank for dividend, or for participation in the assets of the Company in case of liquidation, will be £60,256 7s. 6d., against £131,282. You will see, therefore, that the two compromises will materially improve the position of the shareholders who remain. I am sorry to say that the Directors have reason to be extremely earnest in urging you to get your affairs out of the hands of the lawyers. They attend meeting after meeting, and a large portion of their time is devoted to dealing with matters of litigation instead of the business proper of the Company, and it is most sickening to have to see what probably might be made a good business injured and depressed by the quarrels amongst ourselves, and what I cannot help characterising as needless and ruinous obstruction. Gentlemen, I will now move the following resolution :—"That the Directors be authorised and requested to compromise all or any of the actions pending against the Company on such terms as they deem expedient, including the removal of the plaintiffs, or any of them, from the register of members, and the payment out of the funds of the Company of a sum not exceeding £4,000 in respect to the compromise of claims of £20,000 or upwards." Gentlemen, I content myself with that.

Admiral INGLEFIELD seconded the motion.

Mr. MURRAY asked whether they were parting with any of their patents in this compromise?

The CHAIRMAN replied that the compromise bore only on the questions between the Company and the litigant shareholders, and it did not bear in any sense upon the right of the Company to its patents.

Admiral INGLEFIELD said that it would be satisfactory to know what funds they had in hand.

The CHAIRMAN replied the total assets amounted to £20,170, and there were liabilities amounting to £8,474, including the £4,000, so that there was a considerable balance in favour of the Company, independent of the uncalled capital, which they hoped not to have to trespass upon, and which would amount to about £19,000.

In reply to a further question,

The CHAIRMAN said that in addition to what he had mentioned they had the works at Palmadie, which were free from mortgage, and on which they could obtain a mortgage of from £2,000 to £3,000.

Admiral INGLEFIELD: What are the annual expenses of the staff?

The CHAIRMAN: The expenses at the works were, in salaries, £2,100, and they are now reduced about £600.

Admiral INGLEFIELD: Is any profitable business being done?

The CHAIRMAN: The position of the business is very materially altered in two or three respects. The Williams patents show now signs of becoming more valuable to the Company. I think there are indications that we may expect a business in the crossovers and other appliances of which we have the monopoly under the Williams patents. Then at the works there was lost nearly £6,600 a year, and over £9,800 in the eighteen months up to 30th June last. Since then in some months there has been a profit, and in some months there has been a loss; and on the balance for the last three months, including November, I am given to understand there will be no loss at all, so that we have been gradually and steadily improving the position of the Company, and I think if there were any improvement in trade, and if the expected demand for the Williams installation should increase, we may arrive at a period of profit at the Palmadie Works. In London the expenses have been very materially reduced. Formerly the expenses in London for office and salaries were £1,050, and for stationery £100, but now the amount is only £560. An arrangement has recently been made by which a reduction has been effected in the amount of the rent of the Company's offices to one-half. In addition to that another party has some accommodation in the office and pays half the rent, so that our rent will be reduced from about £400 a year to £100. I may add that some time back we bought a patent for the manufacture of waggon fasteners, and I am happy to be able to inform the shareholders that that has proved a very valuable patent. Our annual return from it will be considerably more than the amount we paid for it.

Admiral INGLEFIELD asked the amount of law expenses up to date.

The CHAIRMAN was afraid he could not answer that. There were about £1,500 to £2,000 outstanding.

The resolution was then put to the meeting, and carried with three dissentients.

Great Western Electric Light and Power Company.

The following notice has been sent to the shareholders of this Company, with a notice of an extraordinary general meeting:—

Gentlemen: Your Directors have convened an extraordinary general meeting of the Company to consider, and, if thought advisable, to confirm a provisional agreement entered into with the Anglo-American Brush Electric Light Corporation. This agreement embodies an offer, unexpectedly made by the Anglo-American Brush Electric Light Corporation, to take over your Company as a going concern, paying for each Great Western share 10s. in cash and 15s. in fully paid Anglo-American Brush shares at par. This offer your Directors consider a fair one under existing circumstances, but the responsibility of its acceptance or rejection must of course rest with the shareholders. It amounts briefly to this: you will receive the bulk of the cash now in hand, and you will receive in Anglo-American Brush shares at par the full face-value of all your plant, property, buildings, stock of materials, stores, &c., together with about £4,000 for the good-will of your business. You will thus become partners in the original Company, who have excellent works, a well-organised staff, and sufficient capital to carry out successfully contracts of a magnitude that your Company could not venture upon with the capital at their command. In order to ascertain the value of the Anglo-American Brush shares proposed to be taken in part payment, two of your Directors have had an interview with Lord Thurlow, the Chairman of the Anglo-American Brush Electric Light Corporation, at which the present financial position and future prospects of the Brush Corporation were fully disclosed; and these are, by your Directors, considered sufficiently good to warrant them in laying the present proposals before you. Should the proposed amalgamation be carried out, the distribution of 10s. per share in cash, and the issue of the fully paid Anglo-American Brush shares, will take place at an early date. Your Chairman, Mr. J. B. Braithwaite, jun., will also be invited to join the Board of the Anglo-American Brush Electric Light Corporation, and he will thus still have an opportunity of watching over your interests. Should you decide to reject the offer of the Anglo-American Brush Corporation, your Directors will continue to give their best attention to the affairs of your Company.

At the extraordinary general meeting of the Company, to be held at the Cannon-street Hotel, Cannon-street, on Monday, the 8th inst., at two o'clock, the subjoined resolutions, if deemed advisable, will be passed, which it is intended to submit to a subsequent general meeting for confirmation as special resolutions, viz. :—

1. That the conditional agreement submitted to this meeting, and made between this Company of the one part, and the Anglo-American Brush Electric Light Corporation (Limited), of the other part, be, and the same is hereby approved and sanctioned.

2. That with a view to carrying the said conditional agreement into effect, the Company be wound up voluntarily, and that Mr. Emile Garcke and Mr. F. W. Reynolds be, and they are hereby appointed liquidators for the purpose of such winding up.

3. That pursuant to the Companies Act, 1862, the said liquidators be, and they are hereby authorised and directed to adopt, on behalf of this Company, the said agreement, and to receive paid-up shares in the said Corporation, as consideration for the property thereby agreed to be sold in accordance with the terms of such agreement, and generally to carry the same into effect.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. DEC. 3.		BUSINESS DONE WEEK ENDING DEC. 3. Highest.	Lowest.
Anglo-American	34,	35	36	34½
Do. Preferred	58,	59	60½	58½
Do. Deferred	9,	10	10½	9⅝
Brazilian Submarine	11,	11¼	11 13-16	11 1-16
Cuba	11,	11¼	—	—
Do. Preference	17,	18	17⅝	—
Direct Spanish	3½,	4	—	—
Do. Preference	15,	15½	15½	—
Direct United States Cable	10,	10¼	10¼	10¼
Eastern Telegraph	11⅝,	12	11⅞	11⅝
Do. 6 per Cent. Preference	13⅝,	13¾	13⅞	13⅝
Do. 5 per Cent. Debentures, 1899	104,	107	105	—
Eastern Extension	12,	12¼	12 3-16	12 1-16
German Union	9⅜,	10¼	—	—
Globe Telegraph and Trust	7½,	7⅝	7 7-16	7⅜
Do. Preference	12½,	12⅝	12 11-16	12½
Great Northern	14½,	14⅝	14½	—
Indo-European	32,	33	33½	—
Reuter's	7½,	8	—	—
Submarine	175,	180	—	—
West India and Panama	⅝,	1	—	—
Do. 1st Preference	7½,	7⅝	—	—
Western Brazilian	7,	7¼	7¼	7
Western Union 7 per Cent. 1st Mortgage	120,	122	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	103½	103

TELEPHONES.

Consolid. Telephone and Maintenance	5-16,	7-16	—	—
Oriental	½,	⅝	—	—
United Telephone	11½,	11⅝	11 13-16	11 5-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅛,	1⅜	1 9-16	1⅛
Do. (fully paid)	3⅛,	3½	—	—
Hammond Light (£3 15s. paid)	⅛,	¼	13-16	11-16
Swan	—	—	1-16	—
Maxim-Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35⅝	34½
India Rubber, Gutta Percha, and Telegraph Works	23,	24	23½	23⅜

TRAFFIC RECEIPTS FOR NOVEMBER, 1884.

COMPANIES.	Nov., 1884.	Nov., 1883.	Increase.	Decrease.
Cuba Submarine	—	—	—	—
Direct Spanish Telegraph	1,736	1,781	—	45
Eastern Extension	42,286	36,719	5,567	—
Eastern Telegraph	55,640	49,390	6,250	—
Great Northern	22,800	—	—	—
West Coast of America	—	—	—	—

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NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 5th Dec. amounted to £4,152.

PERSONAL.—Mr. Joseph S. Beeman, A.M.I.C.E., M.S.T.E., engineer and electrician, has opened offices for private practice at 48, Imperial-buildings, Ludgate Circus, London, E.C.

THE TELEPHONE IN FRANCE.—Between the 27th November and 4th December of this year, the Société Générale des Téléphones enrolled 25 new subscribers in Paris alone; and, between the 23rd and 29th November, four at Bordeaux, one at Marseilles, and one at Nantes.

ELECTRIC LIGHT IN THE HOUSE.—It was intended to considerably extend the partial use of the electric light in the House of Commons before next session; but the autumn session has prevented the work from being carried forward, and it is now indefinitely postponed.

HENLEY'S TELEGRAPH WORKS COMPANY.—This company has been awarded a bronze medal by the International Health Exhibition for their electric light cables. We have been given to understand that not a single fault has occurred in any of the cables during the whole time of the Exhibition.

ELECTRICITY AND THE FRENCH NAVY.—Lectures on electricity are given to officers of the French Navy twice a week at the Paris Observatory, where next year's Electrical Exhibition is to be held, under the auspices of the Société Internationale des Electricians, entries to which close on the 25th instant.

BOOKS RECEIVED.—"Magneto and Dynamo Machines," translated from the German of Glaser de Cew by F. Krohn, and specially edited, with additions, by Paget Higgs, LL.D., D.Sc. Symons and Co., 27, Bouverie-street, E.C.—"Electricity, Magnetism, and Electric Telegraphy," by Thomas D. Lockwood. D. Van Nostrand, New York.

THE TELEPHONE IN PORTUGAL.—According to *La Lumière Electrique*, the King of Portugal has placed the telegraph lines of his kingdom at the disposal of Herr Cornelius Herz, for experiments in long-distance telephoning, to be carried out with the co-operation of M. Marcel Deprez, who in France is identified with the electrical transmission of power.

FRENCH EDISON COMPANY.—The Société Electrique Edison has lately supplied 25 lamps to M. Francillon's dye-works at Puteaux, near Paris; 25 lamps to M. André's Tour-du-Pin works at Lyons; 100 lamps to M. Petit's spinning mill at Pont-Audemar; 40 lamps to M. Chatelard's lace factory at Tarare; and 500 lamps to the spinning mill of M. Droulers-Vernier at Lille.

OVERHEAD WIRES.—On Tuesday last Sir Charles Dilke authorised a statement to be made in his name to the Chelsea Vestry, of which he is a member, to the effect that the Local Government Board were pledged to move for a committee on the subject of overhead wires, and it was hoped that, on the report of that committee, a Bill would be brought in by the Government early next Session.

SMITHFIELD CATTLE SHOW.—This annual show was held during the past week in what is to be henceforth known as the "Royal" Agricultural Hall. It is a pity that the company did not celebrate the bestowal of such a title by illuminating the building in a right royal manner, and supersede the old rings of gas jets, which must exert a deleterious influence on the poor beasts during the last week of their existence.

PHOTOS OF ELECTRIC SPARKS.—At the last meeting of the French Academy of Science M. Jamin submitted to the members some photographs of electric sparks obtained by M. Ducretet directly, without object, by the passage of the spark on the sensitised film of the glass. At the same meeting M. Bochefontaine sent a note through M. Richet recalling his experiments on the diffusion of electric currents in the tissues of animals.

TELEGRAPH COMMUNICATION WITH WEST AFRICA.—The India Rubber, Gutta Percha, and Telegraph Works Company have received a telegram from their engineer, Mr. Robert Kaye Gray, announcing the completion of the Spanish National Telegraph Company's cable between Teneriffe and the French West African colony, Senegal, by which the latter is put into communication with Europe through the same company's existing cable from Cadiz to Teneriffe.

THE VAN RYSSELBERGHE SYSTEM.—With regard to this system of simultaneous telegraphy and telephony, the *Bulletin* of the Société Belge d'Electriciens remarks that it does not depend on the use of special microphones or telephones, as in the early experiments. Nor is it any longer necessary to amplify the telephonic voice so as to overcome the noises due to telegraph induction; on the contrary, this induction is annihilated by the graduation of the telegraph currents.

ELECTRICAL STANDARDS.—Mr. R. T. Glazebrook has had occasion to compare with ten standard B.A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 9·98335 B.A.U. at 14°·05 C., while Lord Raylelgh found the value 9·98330 B.A.U. Thus, either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent.—*Mechanical World.*

MODEL OF TRAIN WORKING.—A model has been exhibited at Berlin showing, on a small scale, all the trains running on a railway system. The object is to prevent collisions by having constant intelligence of the relative positions of the trains. The lines are shown on a plate of dull glass, the stations being numbered. Small arrows, representing the trains, are moved, by means of electric current and brushes on the engines making contact with zinc bands along the rails, exactly in ratio to the real progress of the trains.

TELEGRAPHIC COMMUNICATION WITH WEST AFRICA.—Mr. Wm. J. Tyler, secretary of the India Rubber, Gutta Percha, and Telegraph Works Company, 106, Cannon-street, E.C., received on Monday last a telegram from their engineer, Mr. Robert Kaye Gray, announcing the completion of the Spanish National Telegraph Company's cable between Teneriffe and the French West African colony Senegal, by which the latter is put into communication with Europe through the same company's existing cable from Cadiz to Teneriffe.

NIGHT SIGNALS IN THE FRENCH NAVY.—In a paper on this subject, read before the Société Internationale d'Electriciens, M. A. de Meritens described apparatus suitable for giving these signals electrically, and quoted the following sentence from the report of the committee on the subject, after 20 minutes of experimenting:—"This system of signalling must introduce such a change into naval tactics, that it is desirable that all the vessels should be provided with it."

ELECTRICAL TRANSMISSION OF POWER.—In a paper on this subject, by M. Hillairet, printed in the *Bulletin* of the Société Internationale d'Electriciens, he describes how an apparatus may be combined which will give immediately a true diagram of the dynamo employed. Such an apparatus would unite

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the organs of a registering dynamometer with those of a tacheometer, the motions of which organs would give the variations of speed in *abscissæ* and the variations of moment in ordinates.

ELECTRO-CHEMICAL EQUIVALENTS.—In a note to the Académie des Sciences, Dr. Thommasi proposes to complete the tables of electro-chemical equivalents by an indication of the *calories*, or heat units, of combination, expressed in volts, of each compound. In this manner, it will be known, for instance, that for an amp-hour to be able to decompose 2·98 grammes of sulphate of copper or 3·02 grammes of sulphate of zinc, and so on, the current must have an E.M.F. at least equal to 1·4 volt for the former and 2·46 volt for the latter.

THE EASTERN TELEGRAPH COMPANY.—This company announces the payment, on 15th January next, of a dividend of 3s. per share on the preference shares of the company, less income-tax for the quarter ending 31st instant; and that an interim dividend of 2s. 6d. per share in respect of profits for the quarter ended the 30th September last, with a bonus of 1s. per share for the half year ending that date, on the ordinary shares of the company, free of income-tax, will also be paid on the same date, making a total dividend for the half year at the rate of 6 per cent. per annum.

CAPACITY OF A CONDENSER.—With reference to a formula by J. J. Thomson as to the capacity of a condenser and the number of vibrations of a diapason, M. Brillouin concludes a note in *L'Electricien* as follows :—"If the E.M.F. of the battery is not independent of its capacity, the equations of the variable condition are dependent upon the law of polarisation of the battery and the phenomena of induction ; the distribution of the quantities of electricity among the different wires no longer follows the same laws, and the problem becomes so complicated as to deprive it of all practical interest."

GROSVENOR GALLERY.—The selection of tenders for the work has been made, and the work commenced. Messrs. Marshall, Sons, and Co., of Gainsborough, have obtained the contract for the engines and boilers ; Messrs. Paterson and Cooper, of Little Britain, the contract for supplying and laying conductors, &c. ; while Messrs. Faraday and Sons, of Berners-street, have obtained the contract for fittings. The two main picture galleries will be lighted by Sun lamps supplied and erected by the Sun Electric Light Company. The whole installation is expected to be completed and at work in the course of three or four months.

INVERSION OF CURRENT BETWEEN DIFFERENT METALS.—In a paper before the Académie des Sciences, Paris, on "An experimental demonstration of the inversion of the electromotive force of iron and copper contact at a high temperature," M. F. E. Le Roux, continuing the investigation of a fact ascertained by the French *savan* Peltier, that the surface of contact of two heterogeneous metals becomes heated or cooled according to the direction of the electric current by which it is traversed, found that, at or about a temperature of 1,000deg. C., a current from copper to iron heated the surface of contact, but cooled it at the ordinary temperature.

LAWS OF FRICTION.—At the meeting of the French Academy of Science, on 17th Nov., M. Marcel Deprez, whose method of transmitting power by electric current is shortly to be put in practice between Creil and Paris, cited an experiment according to which the coefficient of friction, a function of the speed, diminished with great regularity in direct ratio with the speed, insomuch that its value varied as 5 : 1, while the speed fell from 550 to 145 revolutions per minute. From 145 to 120 revolutions per minute it remained practically constant, while it again increased rapidly in proportion as the speed approached zero. The absolute value of this coefficient is 0·025 for a speed of 550, and 0·005 for 145 revolutions per minute.

ELECTRIC LIGHTING AT THE SOCIETY OF ARTS.—Up to the ordinary meeting last week, the current has been obtained from a dynamo worked direct by a gas engine, the fluctuation in the lights being very perceptible. On Tuesday, December 2, the Electrical Power Storage Company received instructions to put in a set of their cells to act as a regulator; and by the next afternoon the cells were at work, supplying the lights in the committee room. During Mr. Preece's lecture on Wednesday evening, December 3, the large hall was lit from the gas engine and dynamo, with the cells on a "shunt." The lights were rendered absolutely steady, and the efficiency of cells used as a regulator in this way was clearly shown.

THE TELEPHONE IN THE NORTH.—At the special meeting of the Lancashire and Cheshire Telephonic Exchange Company, held in Manchester on Wednesday, it was announced that, under the new agreement made with the Post Office authorities, the business would be extended by opening "call" offices in various parts of Manchester and Liverpool and at the railway stations within the district, thus establishing communication between the principal towns of Lancashire, Cheshire, and Yorkshire by means of trunk lines, while offices for domestic subscribers would be opened in several portions of Manchester, Liverpool, and other towns. Arrangements were also being made by which subscribers could receive and despatch telegrams by means of the telephone.

SOUTH FORELAND LIGHT EXPERIMENTS.—The series of experiments at the South Foreland, with a view to determine the relative power of various illuminants, is now concluded ; and the experts employed by the Trinity House authorities are engaged in examining and summing up results. Besides the regular observations of their own *employés*, deputed to note the relative power and quality of the lights at certain times and at various points on the paths marked out for the purpose, an appeal was made to captains of vessels passing the Foreland to record their observations in books furnished to them for that purpose. A notice has now been issued to these captains asking them to forward the books containing their entries to the Trinity House without delay.

ELECTRICAL NOTATION.—At a recent meeting of the Société Internationale des Electriciens, M. Hospitalier read a paper on "Uniformity of Electrical Definitions, Conventions, Notations, and Symbols," at the end of which he moved the following resolution :—"We propose the nomination of a commission of electrical notation, charged with studying the question, and giving our proposition the sanction which seems best in the interest of electrical science." This was seconded by M. G. Cabanellas, and adopted unanimously, the following members being appointed to serve on the committee :—MM. Ed. Becquerel, E.-E. Blavier, Marié-Davy, Tresca, H. Becquerel, G. Cabanellas, J. Carpentier, Gauthier-Villars, E. Hospitalier, Maurice Lévy, G. Lippmann, Félix Lucas, Mercadier, De Méritens, D. Monnier, D. Napoli, Pollard, J. Raynaud, and V. Williot. The first meeting of the Electrical Notation Committee was fixed for the 10th inst.

CATALOGUE.—Messrs. King, Mendham, and Co., of the Western Electrical Works, Bristol, have sent us their new price list of electric and magnetic apparatus as supplied to the University Colleges of Bristol and Nottingham, and also to the Science and Art Department, South Kensington. It includes their improved pattern of the new self-exciting Wimshurst Influence Machine, which consists of two circular discs

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of glass, rotated in opposite directions by a handle and pulleys below, one band being crossed to produce the requisite contrary motion. Upon each exterior face of the glass discs, strips of brass are fixed, which during a certain part of each revolution exert an influence upon those immediately opposite to them. The electricity is collected from these strips by wire brushes, fixed to forked conductors, whence it passes to two terminal electrodes above the machine. Both positive and negative electricity are collected from the machine, which enables the experimenter to obtain more intense results.

PRIMERS OF ELECTRICITY.—The "Primers of Electricity," by Professor E. J. Houston, now number twenty-five in all, and can be had upon application to the Librarian of the Franklin Institute. Price, 50 cents. Over 70,000 of these primers were sold during the exhibition. The following is a complete list of subjects represented:—

No. 1. Arc Lights.
,, 2. Incandescent Lights.
,, 3. Dynamo-Electric Machines.
,, 4. Voltaic Batteries.
,, 5. Electric Circuits.
,, 6. Effects of an Electric Current.
,, 7. Magnetism.
,, 8. Electro-Magnetism.
,, 9. Electricity produced by Friction.
,, 10. The Telephone.
,, 11. The Microphone.
,, 12. The Storage Battery.
,, 13. The Electric Telegraph.
,, 14. Electro-Metallurgy.
No. 15. Electric Motors.
,, 16. The Transmission of Energy.
,, 17. The Lightning Rod.
,, 18. The Galvanometer.
,, 19. Electric Measurements of Minute Time.
,, 20. Electric Clocks.
,, 21. Synchronous Multiplex Telegraphy.
,, 22. Electric Arc Lamps.
,, 23. The Ruhmkorff Induction Coil.
,, 24. The Jablochkoff Candle.
,, 25. Sources of Electricity.

STANDARDS OF RESISTANCE.—M. J. René-Benoît has constructed some standards, the resistance of which is equal to an ohm within one hundred-thousandth, which were submitted to the French Academy at the meeting of the 17th November. As these standards are too fragile and inconvenient for ordinary use, he has also made a certain number of copies, which give the same resistance in a more manageable form. They consist of columns of mercury, contained in tubes bent back symmetrically several times upon themselves, and dipping at the top into cups of sufficiently large diameter. The cups are connected with the tube by indiarubber rings and remain open, which facilitates adjustment and permits of renewing the mercury when occasion requires. The copies have been adjusted by comparison with the standards, by carefully grinding away the ends of the tube until they give the same resistance as the standards. They have always, like the standards themselves, been filled *in vacuo*.

ELECTRIC LIGHT ON THE G. E. R.—Electric light plant is being put down by Messrs. Heenan and Froude, of Manchester, for lighting railway carriages on the Great Eastern Railway. Seven trains have been running since the 1st October without a hitch. The dynamos are driven by Messrs. Heenan and Froude's high-speed spherical "Tower" engines, engine and dynamos being 3ft. 3in. long over all, by 13in. wide and 2ft. high. They are placed on the locomotive boiler behind the dome, and clear of the side view of the driver, as it occupies a centre position on the boiler. Steam is taken from the dome, and exhausts by the chimney. The dynamo used is that made by R. E. Crompton. The engine, which develops 10 horse-power and makes a thousand revolutions a minute, weighs only 57lb.; and the dynamo, engine and bed complete weigh 3½cwt. The wires and lamps are so arranged as not to prevent oil lamps from being put in at a moment's notice in the event of a train being divided from the main, and run on to a branch line; but the Great Eastern Railway Company contemplates applying the electric light to the whole of its trains.

INTERNATIONAL INVENTIONS EXHIBITION.—The applications for space have now all been examined by sub-committees of the council, and a selection has been made of the most promising. The number of applications has been so great that it has been decided to limit very strictly the admissions in those classes which may be considered to have been fully represented in the Exhibitions of the present and of the past year. The council will therefore be obliged to refuse many valuable exhibits in such classes as those relating to food, clothing, and building construction. It will even be a difficult matter to accommodate those which have been selected, and it is feared that the list will have to be still further reduced. As soon as possible, information will be sent to those who have applied for space; but the enormous number of applications, far in excess of what was expected, have made it impossible to do this up to the present. The Guarantee Fund now amounts to £48,280, a sum considerably in excess of that subscribed for the Health Exhibition, or for the Fisheries, the amount for the former being £26,518, and that for the latter £26,656.—*Journal of the Society of Arts.*

ELECTRIC HAIR AND FLESH BRUSH.—The *Scientific American* illustrates this application of electricity, made by the Harbach Electric Department, and consisting of an ordinary hair brush, with a small battery and induction coil attached to the back. The ebonite cell is held between contact springs at each end, and is provided with a screw plug, which is inserted in one end when the battery is not in use; but when in operation this is replaced by a plug carrying a bar of zinc. The current generated by the battery—the exciting fluid of which is bisulphate of mercury—is led to the induction coil, where the strength may be diminished or increased by a tube that slides in and out of the coil. One wire from the coil leads to a metal plate attached to the back of the handle; and the other leads to a plate in contact with bristles made of a suitable conducting material. When the brush is grasped in the hand, the current passes through the body to that point which is in contact with the bristles. It is said that this appliance may be used as a hair brush to relieve neuralgia, headache, and diseases of the scalp, and may also be applied to the body to alleviate rheumatism, paralysis, gout, &c.

SECRECY IN TELEPHONE MESSAGES.—In order to call one of its subscribers, without troubling the others, the Société Générale des Téléphones has hitherto placed, at each station and also at the central office, dials which work simultaneously when the first current is sent along the line, and show when to ring in order to call any particular subscriber. For this purpose, they work hands which move round circles divided into equal sectors, each of which corresponds with a station; and the call is heard at the station answering to the sector on which the index may rest when the call is made from the central office. This arrangement has the disadvantage of making known at all the stations, by the motion on the dials, that a message is about to be sent along the line, so that third parties may conceive the idea of listening. A recent improvement, due to one of the engineers of the Société Générale des Téléphones, permits of avoiding this difficulty. Instead of there being a dial at each station, one only is placed outside the subscribers' premises; and, in addition to the two wires which generally constitute the secondary circuit, there is a third, so arranged that, when the central office is in communication with one of the stations, this communication is interrupted as soon as a third subscriber takes up his telephone.

DAMAGE TO FIRE-ALARM POSTS.—At the Worship-street Police-court, last week, Henry F. Cross, warehouseman, of Lockhurst-road, Clapton; and Henry Weeks, clerk, of Glen-

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arm-road, Clapton, were charged with wilfully damaging a fire-alarm post in Church-road, Hackney.—Inspector Hudson saw the prisoners walking away from a fire-alarm post, and observing that the glass face in front of it was broken, he accused the prisoners of having smashed it. Cross said that the glass was broken by accident, and he was willing to pay for the damage done.—Henry Bliss, the officer in charge of the Amhurst-road Fire Brigade Station, Hackney, stated that, since the alarm posts had been erected in the Hackney district, in March, 1882, thirty false alarms had been made by persons who played with the machines. Each false alarm had been the cause of bringing out 30 fire engines, 100 men, and 20 escapes, much inconvenience and waste of time being caused.—Mr. Hannay said that as far as he knew there was no special provision for punishment in these cases, and there was no evidence here that the glass was broken wilfully. He could therefore only order Cross to pay the amount of damage, 4d., and Weeks was dismissed.—It is not amiss, as the *Globe* remarks, that the readiness for an emergency of men and material should be tested; but this is rather a wanton and expensive way of doing it.

Progress of Science.—At the distribution, on the 10th inst., of prizes awarded by the Science and Art Department, at the Harris Institute, Preston, Professor Tyndall passed in review the advance made in scientific knowledge. In the course of his observations, the professor remarked that, coming near to our own time, we had the number 772 expressing the mechanical equivalent of heat, and in the whole range of science there was not a more important number than this, indissolubly associated with the name of James Prescott Joule. Based on Joule's equivalent of heat was the wider principle of the "conservation of energy," which affirmed the agencies of nature to be indestructible while they were mutually convertible. There was no such thing as the creation of energy in the universe, and, if a new form of energy should appear, the principle of conservation affirmed that some other form of energy must have disappeared to produce it. With Joule's equivalent in our hands we might go into the universe and calculate, as Meyer and Thompson had done, how suns might be generated by the collision of planetary masses, or, asking whence came the heat stored up in our wood and coal, reply that it was derived from the sun. We might pass from the vegetable to the animal world, and learn that all the energies of the latter were also derived from the sun. One could not lift the arm, nor use the voice, without bringing into play the law of "conservation of energy."

Internal Resistance of Dynamos.—M. G. Cabanellas lately read a paper before the French Academy, reproduced in the *Comptes Rendus* of 24th November, 1884, on "Dynamo-Electro Machines; experimental confirmations of two reactions in working, and the effective values of the internal resistance and of the induced magnetism." The paper contains a table of the results obtained from data of experiments made by M. Marcel Deprez with an A Gramme machine, with reinforced electros, running at 1,110 revolutions per minute. Decreasing resistances had been intercalated externally, so as to give increasing currents from 2 to 42 amperes inclusive. Formulæ in support of the figures in the table are also given. He adds:—"The numerical table possesses a special proving value, because it results rigorously from the electrical and mechanical measurements, taken by M. Deprez during the working of a dynamo, the electros of which were balanced on knife edges, so as to permit of direct electro-magnetic weighings. There can, therefore, be no doubt as to the values attributed to the *deficits* and the actual electromotive forces. The table confirms the reality of the two important secondary effects already pointed out and measured, viz., the increase of effective internal resistance, represented by a number of ohms or volts, and the increase of the revolving magnetic field with reference to the static field with the same currents. The detailed examination of the fluctuations shows to what point the intervening phenomena are intimately complex; and this is a proof *a posteriori* of the interest there was in considering and bringing into prominence, at the beginning of our investigations, the two dominants which incontestibly characterise the *ensemble* of the multiple reactions, magnetic, electro-dynamic, and electrostatic, some of which we have pointed out, taking good care not to state that the list should be regarded as complete."

Underground Wires in Washington.—In his annual report upon the streets of Washington, says the *Electrical World*, Captain F. V. Greene, of the corps of engineers, United States Army, pays much attention to the successful operation of underground electric wires in Washington. Substantial progress was made during the year, he says, 6·11 miles of line and 285 miles of wire being laid underground. The report says that the standard cables have been in constant use without a fault for telephone, telegraph, and fire alarm purposes for nearly a year. The telephone wires using the Western electric cables have also been in constant use for about six months, and are eminently successful. The Bankers' and Merchants' and Postal wires are also in daily and successful use. "The Western Union Company, which has one-half of all the mileage of overhead wire within the city limits," the report says, "is alone in refusing, or at least in neglecting, to take any steps towards burying its wires, although urged to do so by the Commissioners. All applications for new poles for the telegraph companies, or for removing their pole lines, have been uniformly refused. Their wires are now much interfered with by the growing trees, and in order to get their wires out of the foliage they have resorted to the expedient of splicing the tops of their poles. But the trees will soon overtake them, and this and the rotting of their poles will in a few years compel a settlement of the matter, even if legislation is not obtained requiring the removal of their main pole lines. . . . The close of this year will see about 300 miles of underground wires for telephone, telegraph, and electric light purposes in full and successful operation in this city. It would seem, therefore, that the day had passed for discussing the feasibility of underground wires, and the time has come for compelling the removal of all overhead trunk lines within a reasonable period."

Audi Alteram Partem.—A correspondent writes as follows to the *Scotsman*, under date Edinburgh, December 9th, 1884:—"The telephone companies appear to propose opening places of call where any person off the street may for a trifling payment—a penny is suggested in some cases—ring up any subscriber, and insist on holding a conversation with him. I do not think the subscribers have been consulted about this, and to me it seems so very objectionable that, convenient as the telephone is in some respects, there may be a balance of advantages in favour of ceasing to subscribe. Even as things are, the considerations are not all on one side. Whatever you are engaged in must be interrupted to attend to some one speaking through the telephone, although if he appeared in person he might have no claim to such prompt and exclusive attention. Then there are persons who insist on discussing important matters of business through this medium, which, at the best, involves a hurried and indistinct conversation, and considerable difficulty in the way of

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a trustworthy record of what has passed. Subscribers have the security at present that none but subscribers can address them in this way, and that these are equally interested in the telephone not becoming a nuisance; but if everybody who has a penny or threepence to spare can insist on being listened to by any of the leading business establishments in a city, we shall only be able to protect ourselves against triflers and intruders by paying less regard to all telephone communications. I hope the project will be reconsidered." It will, no doubt, be necessary ere long to add to "Telephone No. ——" a notice to the effect that between certain hours only will communication be afforded. Prominent members of society will also be obliged, as they appoint a secretary to weed their correspondence, also to appoint a telephonist to sift the verbal communications.

National Telephone Company.—At the second Industrial and Art Exhibition, promoted by the Aberdeen United Trades Council, which was opened in that city on Saturday last, the National Telephone Company exhibited a complete telephone exchange in connection with the Aberdeen Exchange system, and opened an office for the transmission of messages from the public to any subscriber on payment of a small fee. The apparatus includes two standards for carrying wires, with the wires run and in use the same as adopted throughout the city in actual practice, specimens of all the line wire apparatus, such as bolts, swivels, stays, &c., with particulars of the test and strains to which each is submitted. The instruments comprise small switch-boards for connecting subscribers' lines, Bell telephones, Blake transmitters, magneto call bells, switches, automatic fire alarms, Gower-Bell telephones, the original Edison telephone with chalk receiver, Wheatstone testing apparatus, old forms of telephones, "Miller's intermediate switch," for use on switch lines, and a fire alarm call signal for the corners of principal streets. The stand was arranged and fitted up under the supervision of Mr. Jno. D. Miller, the district manager for the company in Aberdeen. Several "call" offices have lately been opened by the National Telephone Company in Aberdeen, where any non-subscriber may hold converse with any subscriber to the Exchange system (within a radius of six miles) on payment of a fee of threepence for three minutes' conversation, and one penny for each additional minute. The company is also prepared to establish branch exchanges in the towns surrounding Aberdeen—Inverurie, Stonehaven, &c.—with connection to the Aberdeen Exchange system. The company has also opened three "call" offices in Leith and Edinburgh, where the public may now hold conversation with any subscriber to the Edinburgh and Leith Telephone Exchange, on the same terms as at Aberdeen.

Electric Light at the Law Courts.—Visitors to the Law Courts during the last few days will doubtless have noticed (and that with pleasure) that our prophecy has been fulfilled, and that the electric light has shone forth before the end of the year. On Monday the lights were kept running until the rising of the judges. As, however, the old oil lamps are still hanging about the building, and as the electric spark, during Monday and Tuesday, has been coming and going at its own free will, without much regard to darkness or daylight, we suppose the running on those days may be considered as experimental only. Bearing in mind the amount of new machinery, belting, and shafting which were set in motion all at once, and the quantity of dust which a daily contemporary so graphically described, it will be evident to our readers that a considerable amount of adjustment was necessary, which could only be effected by practically running the plant. The site of the installation is the vaulted basement beneath the Great Hall, in which also is placed the ventilating and warming apparatus. The electrical plant consists of two single-cylinder Galloway engines, each capable of indicating 110 horse-power, and supplied with steam from two Lancashire boilers. The dynamos are of the Crompton-Bürgin type, self-exciting, and eight in number. One engine and one boiler only are employed in the lighting sevice; the other engine and boiler being in reserve, as is also one of the dynamos. Two machines are employed on the six Crompton arc lights which illuminate the Great Hall, and the other five supply current to the 600 incandescent lamps which light the various courts and corridors. The incandescents, of 20 candle-power each, are arranged in parallel; and, by an adjustment effected at the switch-board, the variation in their requirements is perfectly regulated. The arc lights are of 2,000 actual candle-power each. During the vacation, all the lamps and wires were overhauled and the circuits tested. When all the lights were switched on, on Monday evening, there were only some half a dozen lamps out of the total of over 600 which did not light up. The new Bürgin machines are working splendidly, and so is the engine.

Hammond Electrical College.—The annual *conversazione* of the Hammond Company Electrical Engineering College was held on Wednesday last at the College in Red Lion-square, W.C. The guests were received by the President, Mr. Robert Hammond, and the principal, Mr. Hugh Erat Harrison, B. Sc., many electrical and scientific instruments being explained by them and by Mr. Fred. C. Phillips, the electrical engineer. Although there was a Brush machine for arc lighting, it was not used on this occasion. The rooms were, however, brilliantly lighted by Swan incandescent lamps, with current from an alternate-current Siemens dynamo, excited by a shunt-wound direct-current Siemens machine, both driven by a 6 horse-power Otto gas-engine, capable of working up to 8 or 9 horse-power. In the cellars were thirty-eight 1 horse-power Faure-Sellon-Volckmar storage batteries, of a useful capacity of 100 amp.-hours, coupled in series. They fed 25 ship incandescent lights on the second floor, which shone with remarkable brilliancy, owing to the E.M.F. being rather in excess. On the first floor, Capt. Aylmer, M.P., showed the newest forms of Trouvé's portable lamps, which were illustrated in *The Electrician* a fortnight ago, and formed by no means the least of the evening's attractions. A number of radiant-matter tubes also created considerable interest. A Ferranti ship dynamo was shown in two parts, divided vertically, so that its construction could be examined. A small Victoria A dynamo, made at the Brush works, drove a sewing machine by means of Sir Wm. Thomson's electric motor. In the library, the Electric Apparatus Company had quite an exhibition of new electrical apparatus, including Sir Wm. Thomson's "mouse mill" electric lighter for gas, the sparks from which are produced entirely by friction, there being no battery. All the scientific apparatus belonging to the college was on view; a concert was given by Miss Marianne Fenna, Miss Marian Ellis, Mr. Reginald Groome, and Mr. George Basset, Mr. Thomas Physick presiding at the piano; and altogether a most interesting evening was spent. The membership of the college takes the form of a two years' apprenticeship to Mr. Hammond, the president of the college and managing director of the Hammond Electric Light and Power Supply Company, the course of instruction being arranged with a view to afford a complete theoretical and practical training to those who intend devoting themselves to the electrical engineering profession. Mr. Robert Hammond, who has electrically lighted his house at Highgate, has issued invitations to view the arrangements on Monday next.

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THE STEAM ENGINE INDICATOR.—IV.

BY AMICE.

Kraft's indicator, to which we referred in our impression of the 6th inst., is illustrated by the accompanying perspective and sectional engravings (Figs. 11 and 12). As mentioned in our last, this was one of the first indicators made with a very light pencil arm having a free end. The other moving parts were also reduced to the smallest weight. In our engraving (Fig. 11), *a* is the steam cylinder, fitted with a piston, *b*, the piston being, as is usual in these instruments, made steam tight by a very accurate fit, the cylinder being very carefully bored. No rings or means of making the piston tight, except accuracy of workmanship, are ever used for indicator pistons. The upper part of the cylinder is slightly enlarged and closed by the cover *c*, while the lower part is firmly screwed into the tapered end piece *d*, which fits into the upper part of the indicator cock at *e*, where it is held by the hand nut *f*. The upper part of the cylinder

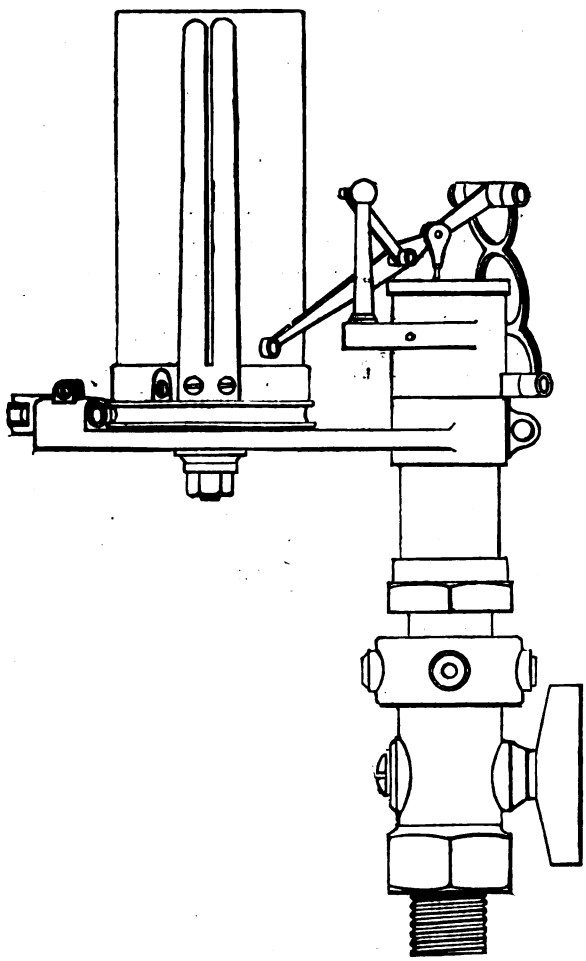

FIG. 11.

is surrounded by a collar, *h*, which carries an ear by which the standard *r* is supported, and a projection to which *q* is articulated, the right line motion of the pencil being obtained by the radius rod and the proportion between its length, the length of *q* and the position of the joints in the pencil arm *p*. To prevent water from sprinkling the diagram paper, as it does when holes for the admission of air above the piston are made in the top cover, they are in this indicator made below the piece *g* which carries the paper drum A. The piston rod *l* is of a trunk form at *m*. The spring, not shown, against the resistance of which the steam raises the piston, is of spiral form, and is provided with a nut at either end, by which it is screwed to the piston at *k* and to the inwardly projecting boss in the under side of the cover *c*. The trunk *m* or tubular part of the piston rod slides through the cover *c*. Within the trunk is the rod *o* jointed to the pencil arm *p*, the lower end of this rod having a ball and socket joint. Our engraving shows the indicator at half size, so that it will be seen that the moving parts are all light. The pencil arm is generally made to carry a metal pencil—for instance, soft brass, to mark on prepared diagram paper. It is, however, also made to take a very hard lead pencil, not only so that ordinary paper may be used, but because some German engineers consider that the friction of a hard lead pencil on glazed paper is less than that of a metal pencil on the prepared paper, known as metallic paper, which is more generally used. There is no doubt that the friction of a metal pencil is greater on the prepared paper than a hard graphite pencil on hard paper, especially when the prepared paper, which is much the more expensive, is in a steamy atmosphere.

The paper drum A moves upon a steel spindle V, screwed into the projection *g* by an ordinary nut. The tube V is loose upon this spindle, and is made in one piece with the pulley *y* and the box *t*, which contains a coiled spring. The piece W is a cover for the spring, and is held in place by the nut X. The drum A is fixed to the pulley *y*, round which is coiled the

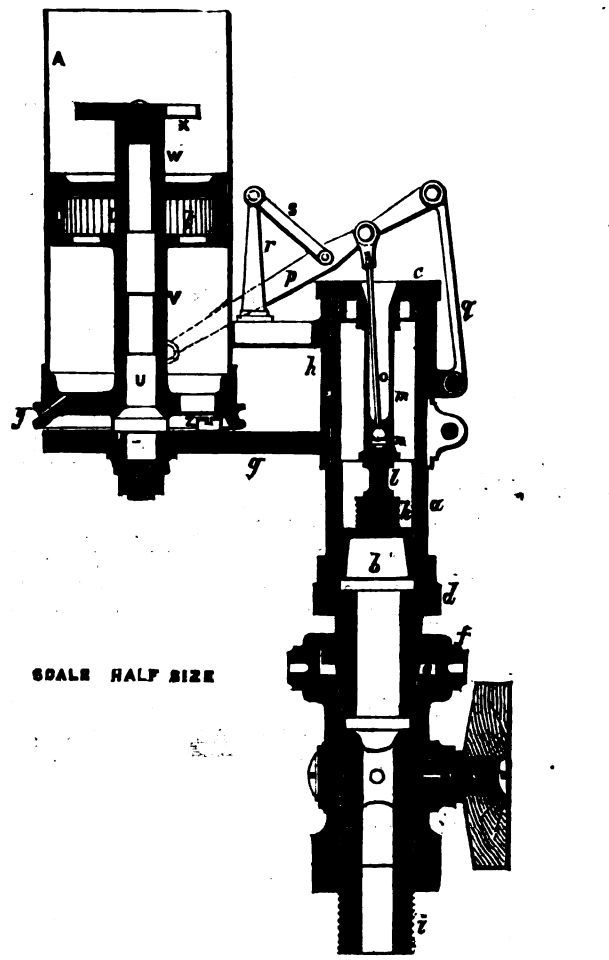

FIG. 12.

string, by which motion is given to the drum from some part of the steam engine. The string is guided to the pulley *y* by a pulley which may be set in any desired direction. The string pulls the drum round through about three-fourths of a revolution against the resistance of the spring at *t*, which forces it back as the string returns.

The plug of the cock to which the indicator is attached is drilled with holes in two directions, so that, as shown, steam may pass from the engine cylinder to the indicator piston, or by turning the cock in one direction steam may be allowed to blow through to the air from the pipe below the indicator, so that any water in the pipe connections may be blown away. If water is in these connections, especially if they are of any length, it will give to the diagram an irregular form, not representative of any action of the steam in the engine cylinder.

The piston springs constitute one of the most important parts of an indicator, and with these generally we shall deal specially when we have given the reader some further particu-

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lars of the indicators most in favour. The next in order is the indicator invented by Mr. E. T. Darke, and which is illustrated by Figs. 13, 14, 15, 16, and 17. One of the most important features in this is the pencil motion, which consists of one steel arm pivotted at one end by

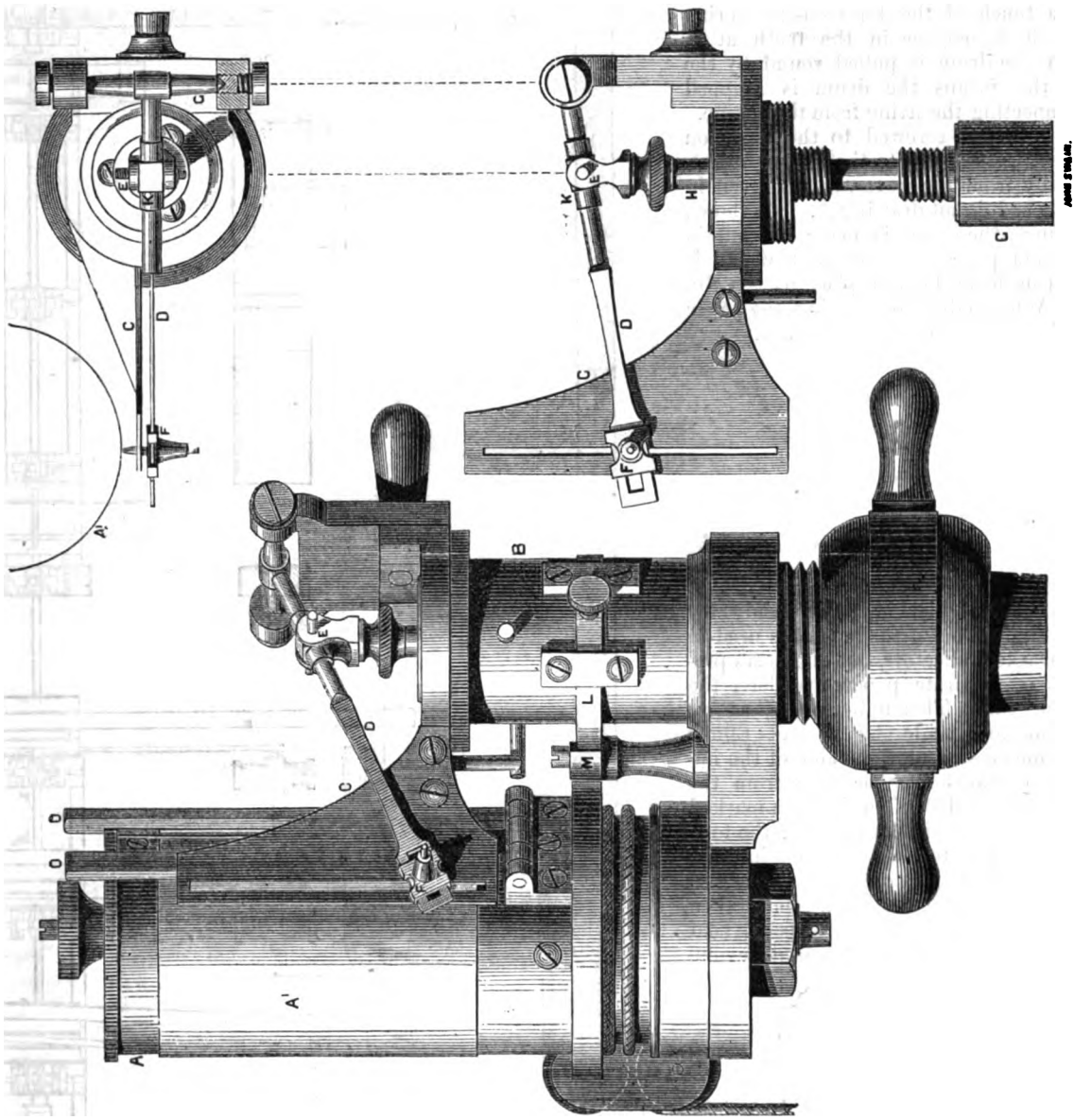

Fig. 15. Fig. 16. Fig. 13.

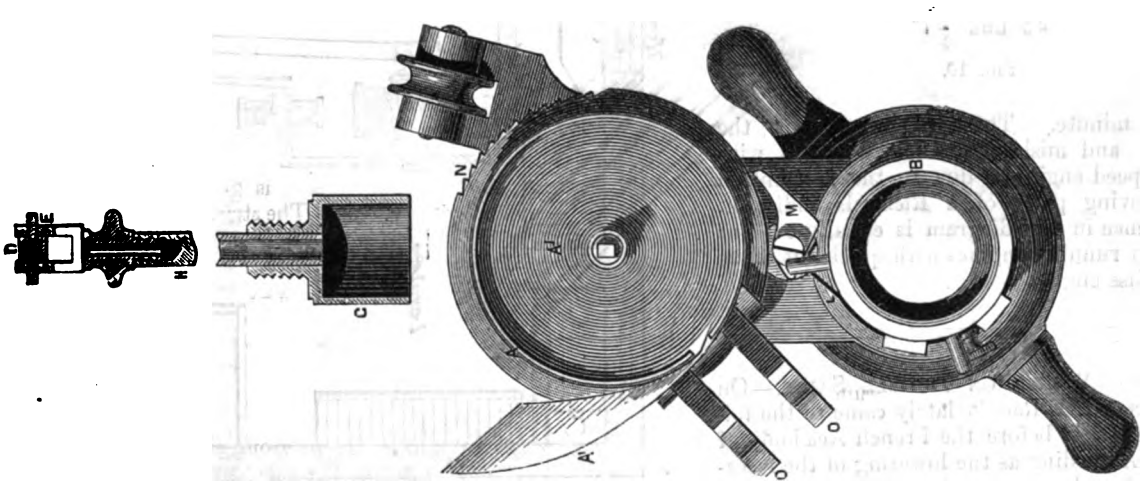

Fig. 17. Fig. 14.

centre points on the two ends of a T head, and carrying at the other a sliding piece, F, which is provided with a holder for a metallic pencil. The pencil is kept in a straight line parallel with the axis of the paper drum by being made to pass through a slot guide in a plate, C. The piston-rod head carries a jaw, E, and in this is a sleeve, K (Figs. 15, 16), which is an accurate but easy fit on the pencil arm, which is made round at this part. With the motion of the piston and the jaw E, the sleeve K is caused to slide through a small range on the pencil arm as the latter describes an arc on its pivots. The end of the pencil arm, also, in a similar way slides in the piece F, which is compelled by the slot to keep the straight line of the slot. Our engraving shows the indicator full size. The piston rod is hollow, see Fig. 17, the piston is made smaller and of shorter stroke than in the Richards,

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and there are differences in the springs and also in the construction of the jaw head seen in Fig. 17, which we need not describe, as the forms adopted are so well shown in our engravings. In Figs. 13 and 14, Darke's detent gear, which we described in our last impression, is seen at M L, the pawl M being out of gear in Fig. 14, but a touch of the knob on the spring L will cause it to engage in the teeth at N (Fig. 14) when the drum is pulled round by the string. By this means the drum is stopped without disconnecting the string from the engine.

The piston spring is screwed to the screw on the piston G (Fig. 16), and to the screw projecting downwardly from the cover, as also seen in the same detached detail drawing A. As shown in our engravings, the drum is made to contain a roll of diagram paper, A', that part which is outside the drum being held in place by the clip springs O O. When a diagram is taken the paper containing it is torn off, the removal in this way

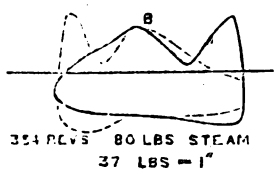


Fig. 18.

bringing forward and placing paper ready for the next diagram. This arrangement is used in most of the Darke indicators, but engineers preferring to put on separate papers may have the drum fitted for this. This indicator is, as we previously remarked, made by Messrs. Elliott Brothers, Charing-cross, and the value of the improvements it contains may be seen from the diagrams (Figs. 18 and 19). The diagram marked B is taken by a Richards indicator from the low-pressure cylinder of a torpedo boat engine, and that marked A from engines of similar construction working under similar conditions, but taken with a Darke's indicator. The torpedo boat engines were running at several hundred revolu-

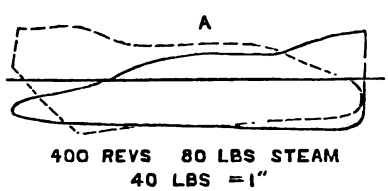


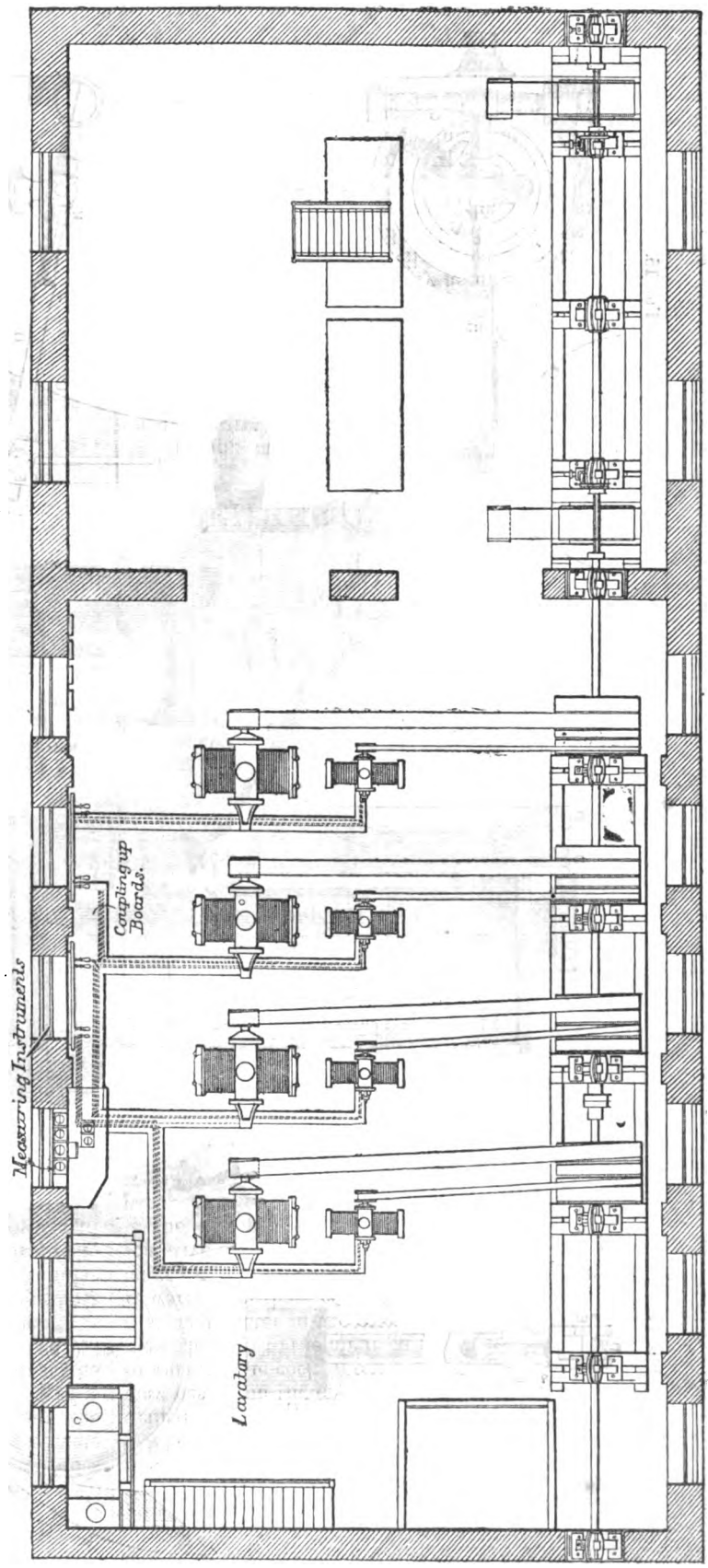
Fig. 19.

tions per minute. These diagrams show the very great and misleading effect obtained with the high speed engine as due to the momentum of the moving parts of a Richards indicator. The difference in the diagram is equally evident from slower running engines with quick cut off as in the Corliss engine.

Action of Water on Double Salts.—On this subject, F. M. Raoult lately came to the following conclusion before the French Academy of Science:—According as the lowering of the freezing point of a double salt, dissolved in water, is equal or inferior to the sum of the partial lowering of the freezing points of the simple salts composing it, it may be affirmed thatthe double salt is or is not entirely separated into its two generators.

VICTORIA INSTALLATION.

Our illustrations on this and the following page show, first, the arrangement of shafting and dynamos on the first floor; secondly, a section of the floors, showing position of boiler, engine, dynamos, &c.



THE VICTORIA INSTALLATION.—Plan of First Floor.

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ELECTRICITY IN EAST JAVA.

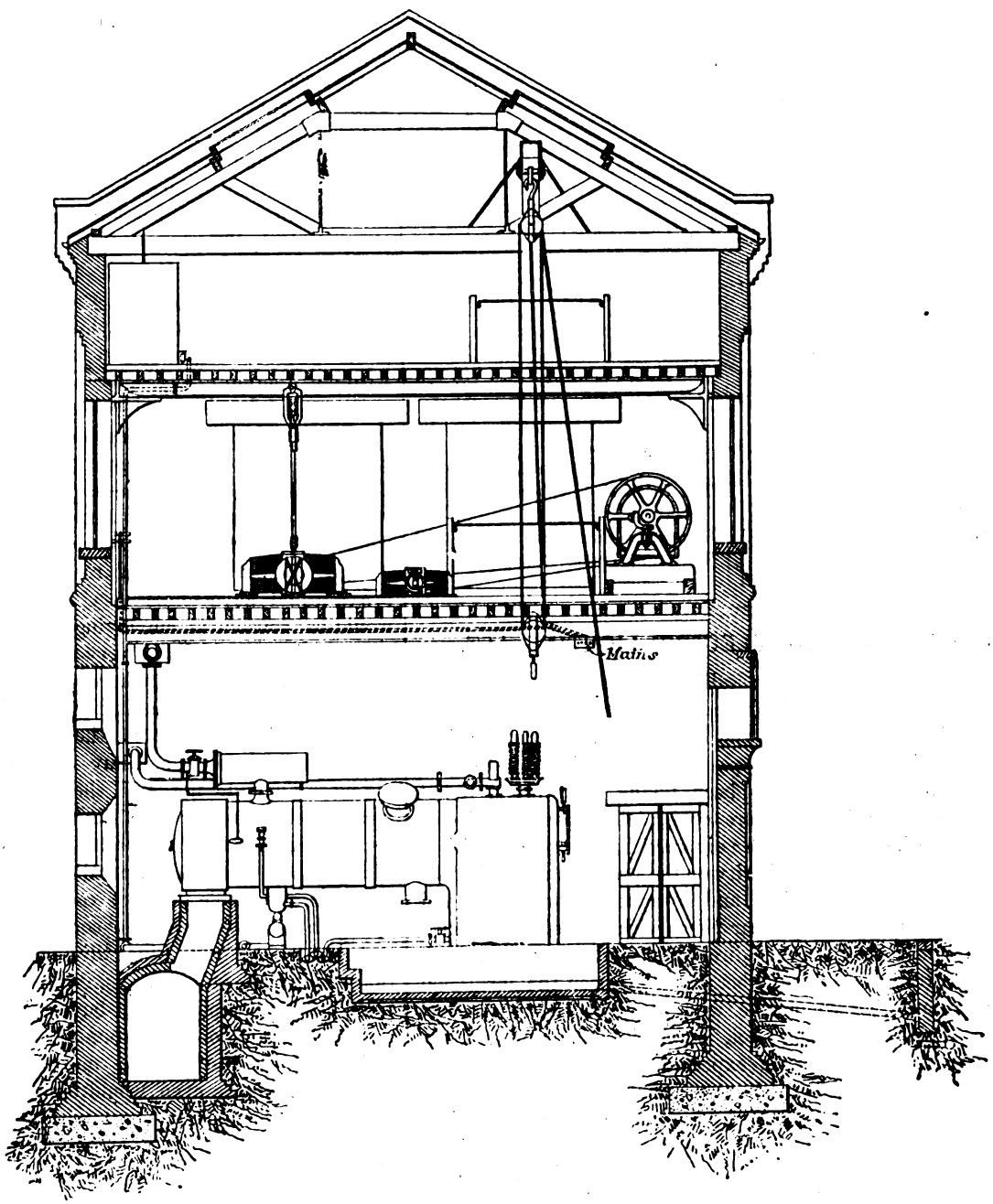
At the beginning of the present year Messrs. Zwieten and Co., of Malang, installed the electric light in the palace and gardens of Sultan H. B. VII., of Djokjakarta, with 200 Swan incandescent lamps (including four in engine room), and four 500-candle Siemens arc lamps, with Siemens dynamos, driven by a 30 horse-power Davy-Paxman engine, with multitubular boiler. After eight months' working the contractor has received a satisfactory testimonial of the results, notwithstanding the fact that the driving and superintendence was left to Java workmen.

In March last the same firm fitted the palace and gardens of Prince Prang Wedono, of Socrakarta, with electric light plant, consisting of five 500-candle Siemens arc lamps, and sixty 20-candle Swan lamps, with Siemens dynamo, driven by a 12 horse-power portable engine. The working of this plant gives every satisfaction; and it is stated that the common teak wood used here as fuel gives no trouble in raising or keeping steam for driving, it being used in portable engines constructed for coal burning.

The Socrabaja-Selosedjo sugar house was next fitted with 500-candle Siemens arc lights (one outside and four inside), and also 20-candle Swan lamps. The firm is now engaged in putting down a large plant, also for Prince Prang Wedono, at Socrakarta, with six arc lights and a hundred Swan lamps.

In sugar houses, the delicate mechanism of the Siemens lamps gives some trouble, owing to steam and dirt. Our correspondent states that next crushing season it is intended to try the Boston 60-candle lamps, some orders being already received; but the prices of sugar, regulated by law, are somewhat of a drawback to progress. As regards electrical transport, there will be much to do in small electric railways before long; and it is thought that a form of telpherage lines was specially invented for coffee planters' use.

In electric lighting there is, of course, a large field in Java, as gas costs 13s. 3d. per thousand cubic feet. This high price would not be maintained but for the slowness of the inhabitants to appreciate the advantages of electric light applied to houses. The monopoly of the gas company would soon be at an end if house-to-house lighting were carried out by means of small caloric engines, or, possibly, primary batteries, as the long distances, added to the great expense for wire, would be against the establishment of central stations.



THE VICTORIA INSTALLATION.—SECTION OF FLOORS.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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EXPERTS ON THE ELECTRIC LIGHTING ACT.

A company of gentlemen calling themselves the "Dynamicables," have, we are informed, met together from time to time to discuss the fortunes and prospects of electric lighting. We may conjecture that the hopes which were nipped in the bud by the winter of 1882 have been trying to survive, if not exactly to bloom, in the more congenial atmosphere of convivial foregathering. Be this as it may, they have established themselves firmly as an authority on the practical and scientific bearings of electric lighting, and by mutual conference and discussion have arrived at clear views with regard to the business in which they are all directly or indirectly interested. The latest result of their deliberations has been the formation of a representative committee, who have drawn up a report on the Electric Lighting Act, embracing the views of the whole body. As might be expected from a company sufficiently good-humoured to discuss their differences round the social board, and sufficiently humorous to style themselves after the manner of the late Mr. Byron, their report is neither violent in its tone nor ridiculous in its conclusions. It does not sin on the side of being too exacting, nor is there any trace of that Philistinism which commonly disfigures such documents by failing to see the funny side of unreasonable pretensions. It is, in short, a plain business-like Report of considerable argumentative merit; and as it is put forward on the authority of the foremost men in the sphere of electric lighting enterprise, both theoretical and practical, it demands and deserves the highest consideration. It has yet to be discussed, we are told, by the whole band of Dynamicables; but except for the light thrown upon the subject by Mr. Chamberlain's recent declarations, no material modification is likely to be made in the Report.

The form of License granted by the Board of Trade for the lighting of Colchester, and the form of Provisional Order adopted by the Board in 1883, have enabled the Committee to see exactly the interpretation put upon the Act by the Board itself. This interpretation the Committee accept as decisive, although on the subject of licenses they think that a different rendering might have been permissible. Facing the situation, therefore, created by the authorities at the Board of Trade, the Committee set themselves to prove that the Act is unworkable as at present administered; secondly, that a few verbal alterations only would be needed to make it workable; and, lastly, that the required alterations are reasonable, just, and indispensable.

As regards the first-named contention, their task is perfectly easy. Events have settled that point for them—or, perhaps we should say, the absence of events, for the Act has literally destroyed what it ostensibly professed to promote. But the Committee have introduced some fresh argumentative matter into the discussion well worthy the consideration of the public as well as of the Board of Trade. It is pointed out that the Gas Companies hold their powers in perpetuity, and can afford to work at greatly diminished profits, which the law allows to be made up in after years by enhanced prices and increased returns. To compete with gas, therefore, any other system of lighting cannot hope to succeed if handicapped by conditions less favourable than those enjoyed by the existing system. In order to make its term of twenty-one years' existence at all remunerative the electric light would have to be charged for, not at a rate comparable with that of gas, but at a luxurious rate, the effect of which would be a restricted demand for it and attenuated profits. To get a fair commercial return within twenty-one years prices would have to be very high—so high as to prevent would-be consumers employing the electric light, and thus ensuring its failure at the very outset of its career.

If, however, the undertakers by low prices create an enlarged demand for their illuminant, they will invite their own ruin by attracting the cupidity of the Local Authorities, who are empowered to step in and buy up the concern. But we are wrong. They do not buy the "concern" in the business meaning of the term; they can force the sale of the plant at its then value, and appropriate the "concern" for nothing. This is a sort of bargain a parallel to which it would be difficult to find in the whole range of commercial experience. A near approach to it would be the compulsory sale of beer-barrels and bottles to the Blue Ribbonists, with no compensation for the publicans' "good will." To make the resemblance complete the buyers would have to step to the other side of the counter, doff their blue ribbons, and carry on the business on their own account. That very small profits even would tempt the Local Authorities to force the undertakers to part with their business is evident when we remember that money may be borrowed for local objects at 4 per cent. By availing themselves of the provisions of the Act they could thus do a good stroke for the ratepayers. The seven years' grace allowed in the event of escaping at the twenty-one does not mend matters in the least; if the undertaking has not become profitable in the longer period its efforts to recoup itself will be paralysed by the certainty of confiscation at the expiration of another seven years.

It was a parochial mind that framed this section, and it should be met by a firm resistance on the part of men who have business minds. Granting, for the sake of argument,

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that the monopoly of Gas and Water companies has worked badly—though we by no means admit the assertion—the terms of compulsory sale, if a transfer is really necessary to prevent such monopoly, should be on a liberal basis; and the Committee of the Dynamicables are, we consider, very moderate in demanding a fair value for the undertaking *considered as a going concern*, a vastly different affair to selling its plant at a valuation. The only other acceptable alternative is a considerable extension of the working period. The Committee do not name an alternative to the twenty-one years fixed by Section 27, probably because it is impossible to make the calculation. It ought to be left for the next generation to determine.

Some modification in the conditions on which light is to be distributed under the Act is also asked for by the Committee. Gas companies, wherever they have supplied their customers without meter, have rightly been allowed to insist on the use of certain burners. The electric lighting undertakers, on the contrary, are required to permit the use of any lamps the users may choose—or, in other words, may consume the commodity as wastefully as they please. Mr. Preece tells us that the Edison meter answers well in New York and registers within about two per cent. But neither the Edison nor any known meter has yet been sufficiently well established to warrant a new undertaking supplying electricity in any other way than by hours, regulated by the lamps provided or approved by themselves. Clause 16 ought to be amended in this sense.

Further, the form of Provisional Order compels the laying down of mains, and additions to them, in such an arbitrary way, that the public have all the advantage and the undertaking all the risks. If the supply is to be compulsory, the price should be regulated by the quantity supplied. An intermittent demand should be met by proportionately high rates for the exceptional convenience and outlay. Lastly, as to licenses, the committee are of opinion that Section 3 of the Act has been erroneously interpreted; and that if the undertakers of limited schemes covered by Licenses are to incur obligations towards the public similar to those imposed in the case of Provisional Orders, legislation as to Licenses will, like all the rest of the Act, remain a dead letter.

CORRESPONDENCE.

PAYING FOR SPECIFICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe in your issue of the 6th inst. a letter, signed "Engineer," accusing Messrs. Mackenzie and Brougham of making improper charges for specifications issued by them on my behalf for work to be done at the Grosvenor Gallery, in *re* electric lighting.

Messrs. Mackenzie and Brougham had my instructions to issue separate specifications and forms of tender for each branch of the work, and not to deal with it as a whole.

I also instructed them to divide the expense of preparing the specifications between me and those who should apply for them, my object being to lessen my own expense, and to limit the competition to those who acted with a *bonâ fide* intention of dealing with the matter.

Please insert this letter in your next issue.—Yours, &c.,

COUTTS LINDSAY.

11, Grosvenor-square, Dec. 9.

[We beg most emphatically to protest against this statement. Our correspondent did not accuse Messrs. Mackenzie and Brougham of making improper charges. Our correspondent's words are, "are asking, under the powers vested in them by the Grosvenor Gallery proprietors, &c." Sir Coutts Lindsay states that the charge was made according to his instructions, and we, in the interests of electric lighting, protest against such instructions in the strongest possible manner. The action of Sir Coutts Lindsay has been this, that almost every company and firm of repute has refused to tender, or has withdrawn its tender, a fact which furnishes a complete justification of our correspondent's remarks.—ED. *E.*]

To the Proprietor and Editor of *The Electrician*,
1, Salisbury-court, Fleet-street.

GENTLEMEN: We have been consulted by Messrs. Mackenzie and Brougham, of 15, Great George-street, with reference to a libel published by you on page 73 of the number of *The Electrician* issued on the 6th December, under the heading "Paying for Specifications."

In that letter you impute to them dishonest and improper practices; and as they have already applied to you for the name of the writer of that letter, which has not been furnished, we are instructed to inform you that unless an ample retraction and apology, to be settled by us, be published, together with payment of costs occasioned by the libel, we are to commence an action against you.—We are, yours obediently,

LEWIS AND LEWIS.

10 and 11, Ely-place, Holborn, London, E.C.
Dec. 10, 1884.

[Once again, it seems, in our endeavours to protect the true interests of electric lighting we are threatened with a libel suit. Our answer to Messrs. Lewis and Lewis, in this case, is furnished by Sir Coutts Lindsay's own letter above, and our remarks upon it. The statement that "dishonest" practices were imputed to Messrs. Lewis' clients is wholly unfounded. That is all we have to say.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "To be or not to be" (paid for)? "that is the question." Of course, no one will doubt the propriety of paying the consulting electricians for their work in getting out forms of stipulations, fines, &c., as people naturally expect to get paid for this kind of thing; but who is to pay them? One would think that those who engaged them and so received the benefit of their services would be willing to pay for the protection afforded; but still, when I think of that very interesting tale of the monkey and the cats I am fain to learn a lesson from it. The monkey, as you will no doubt remember, had a nibble *both ends* of the cheese, and what the cats got for their share was the rind, plus the trouble of getting it.

Another instance just occurs to me of a plan adopted by unprincipled surveyors of getting paid at a cheap rate to their employers, and no doubt if the case under consideration is allowed to pass unchallenged the same may be enacted in a more scientific branch of business. I refer to the position of the builder who, before he obtains an advance, is obliged to agree to a large percentage being paid to the surveyor, otherwise no certificate is forthcoming.

These are extreme cases of extortion, but they have small beginnings, and surely electric lighting is not coming to this. A contractor, after he has spent some ten or twenty pounds in getting out a tender and specification, with suitable tracings, ought certainly not to be mulcted in a payment of £3 for the schedule of restrictions, &c.

It is a well-known fact that however well the consulting engineers do their work, new specifications, designs, &c., have to be got out by the contractors for their particular class of machinery.

Could not some plan be devised by which the successful tenderers should pay an amount approximately equal to that which would be lost by returning the £3 each to those who are unsuccessful?

As the case in question appears to be the first of its kind in the electrical world, where the money paid for specifications is not returnable, the matter ought to be met at the outset, and united action on the part of the leading companies taken. If, then, an attempt at extortion be made in the future, it will be

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well known that should any tenders be received they will be from none but second-rate contractors and treated accordingly.
—Yours, &c., JONATHAN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent "Engineer" in your last issue calls attention to the conduct of certain consulting engineers who, under the powers invested in them by the Grosvenor Gallery proprietors, asked three guineas for their specifications, and which sum is not returnable. Now, without endorsing the language of your correspondent, which I think is unnecessarily harsh (as, from my personal knowledge of the gentlemen referred to, I am certain that they had no such intention as he imputes to them), still, as you, sir, call for some expression of opinion on the subject, I take this opportunity of protesting against the proceeding. I think most engineers will back me up when I state that such fees for specifications are *always returnable* on receipt of a *bonâ fide* tender.

Electric light engineering is work of such a tentative class that all of us engaged in the trade are compelled to maintain an expensive staff of engineers and draughtsmen solely for the purpose of preparing a vast number of schemes, each consisting of reports, specifications, drawings, and estimates, the greater portion of which do not come to fruition solely because of the public belief that by waiting a "bit longer" some great and startling improvements will crop up which will enormously reduce the first cost of the plant.

As the cost of this estimating staff must eventually come out of the pockets of those who *do* purchase electric lighting plant, it is most undesirable in the interests of the public that it should be further increased in any way.

I addressed a circular letter to the trade on this subject, and I may say that in every instance save one I received replies agreeing with what I have above stated, the one exception being of course from the firm who was successful in obtaining the order.—Yours, &c., R. E. CROMPTON.

Mansion House-buildings, London, E.C.,
Dec. 11, 1884.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We fully endorse "Engineer's" opinion as expressed in last week's issue, and we think the fees should at least have been returned when the tenders were sent in, as is usual in most cases where a charge is made for a specification.

We can only hope that the Grosvenor Gallery proprietors will accept one of the tenders, so that some member of the profession will have the benefit, and that the trouble which many firms have taken will not be entirely lost.—Yours, &c.

OPPERMANN BROTHERS.

London and Chicago, Dec. 6, 1884.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We object to payment for the specifications referred to—not only because the attempted innovation is quite unsuited to the present position of the electric lighting business, but also because in the case of the Grosvenor Gallery the specifications were for part only of the electric lighting plant, the companies tendering having no voice in the selection of the dynamo machines to be employed. Furthermore the engineers informed me that the dynamo machines they intended to use would not be capable of charging storage batteries, for which no provision was made.

I think that electric lighting companies in tendering for any important work should be able to tender for a complete installation. It is all very well for the engineers who prepare specifications to assume all the responsibility; but, if the lighting be unsuccessful, depend upon it that the parties whose reputation is really at stake in the eyes of the public are those whose lamps go out, whatever the cause may be.—Yours, &c.,

GEO. OFFOR,
Manager of the Consolidated Electric Company (Limited).

67A, and 68A, Cow Cross-street, December 10th, 1884.

THE GULCHER ELECTRIC LIGHT COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your report in yesterday's *Electrician* of the meeting of the Gülcher Electric Light and Power Company (Limited) (the accuracy of which I do not question) states that "misrepresentation" has been applied to me with regard to transactions I have had with the company.

As the case is *sub judice*, I cannot ask you to allow me through your columns to vindicate myself, but as my silence under such an accusation may be open to misconstruction, I would ask you to permit me to say that I am advised that I have a most complete answer to the case which the company sets up against me, and that the chairman of the company, in his speech to the shareholders, forgot or omitted to mention (probably owing to his recent connection with the company) the sacrifices I have from time to time made in their interests, and the confirmation over and over again by the company of my past dealings with them, of which dealings they now for the first time complain.—Yours, &c., WILLIAM CROOKES.

London, Dec. 6, 1884.

ILLEGAL PRACTICES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We find that certain people have been making incandescent lamps, looking externally like ours, with the exception that the finish is not so good, and have been selling them as ours at a low price.

We should be much obliged if you would notice this in your next issue, calling attention to the fact, as, of course, it is doing us much damage, besides being unnecessarily disappointing to the purchasers of the lamps.—Yours, &c.,

WOODHOUSE AND RAWSON.

11, Queen Victoria-street, London, Nov. 28th.

ELECTRIC LIGHTING IN AMERICA.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The report of the meeting of the Society of Arts upon this subject must have aroused a feeling of shame and indignation in the minds of all your readers who are interested in electric light—shame, that as a nation we should be so far behind America in what is now admitted on all hands to be the most conspicuous improvement and advantage which modern ingenuity has devised; and indignation, that this result should have been brought about by the passing of an ill-digested Act of Parliament in a period of panic.

The public are now weary of the oft-repeated tale, which has been told *usque ad nauseam*, that "the whole thing was premature;" that "an attempt was being made to create another monopoly;" that "promoters had made large sums of money;" that "the object in view was the sale of worthless patents rather than the establishment of a valuable industry," &c. Be it so. But this fact remains, and cannot be gainsaid, that until the Electric Lighting Act be repealed or materially altered no rational men will now embark their money, nor will any honest and prudent Board of Directors lay out the money of their shareholders in electric lighting enterprises in this country.

In the neighbourhood where I live (Marylebone) the streets are simply unsafe after dusk on account of the feeble light from the gas lamps, except on moonlight evenings. At other times a torch or bull's eye lantern is almost a necessity in crossing the streets.

I am only one of tens of thousands in London who would gladly pay anything within reason to have the electric light inside, as well as outside, their houses. Gas is so injurious to health, and so detrimental to furniture, ceilings, pictures, &c., that I have resorted to the use of oil lamps and candles almost throughout my house.

Before Mr. Chamberlain's Act was passed I made two or three efforts to get the electric light introduced into the neighbourhood where I reside, and should probably have succeeded; but before I could bring these efforts to a successful issue the Act was passed, and the company with whom I was in treaty

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and I myself saw that they were hopeless, and I abandoned them.

Is the foolish fear of a monopoly to stand any longer in the way of the successful prosecution of a discovery which is so beneficial to health, so preservative of property, and last, but not least, so conducive to public safety that the Chief of Police in New York has gone so far as to say that "every electric light erected means a policeman removed"?—Yours, &c.,

December 10, 1884. R. B.

[Owing to pressure on our space, we are compelled to leave over till our next issue letters from Mr. W. B. Esson and "Zero."]

THE ALTERNATE-CURRENT MACHINE AS A MOTOR.*

BY PROFESSOR W. GRYLLS ADAMS, F.R.S., PRESIDENT.

(CONCLUDED FROM PAGE 76.)

On November 10th, I again made further experiments with the three De Meritens magneto machines, and made measurements of the light given by the arc worked from the machines separately and combined in parallel circuit.

The resistance of the leads from the engine room to the photometric gallery in which the measurements were made was ·032 ohm (cold) and the leads were heated considerably, and where exposed became quite warm to the touch when carrying the current from two machines or from the three machines.

One machine alone gave a current of 175 amperes, with an electromotive force of 40 volts at the machine terminals, and an electromotive force of 33 volts at the extremities of the arc, giving 5,775 watts expended in the arc and 1,225 watts expended on the leads.

Two machines worked well together, being driven independently, and gave an average current of about 275 amperes, with an electromotive force of 47·5 volts at the machine terminals, and an electromotive force of 35·5 volts at the extremities of the arc, giving 9,750 watts expended in the arc and 3,300 watts expended on the leads.

Another experiment with two machines gave an average current of 278 amperes, with an electromotive force of 48 volts at the machine terminals, and an electromotive force of 36 volts at the extremities of the arc, giving 10,000 watts as the energy per second expended in the arc.

These experiments give for

(1) One machine—
7,000 watts (electrical energy in external circuit);
1,715 watts (electrical energy in internal circuit):
giving 8,715 watts as the total electrical energy per second.

The power absorbed, as shown by indicator diagrams, during this running was 13·8 horse-power, or 10,295 watts, giving an electrical efficiency of 84 per cent.

(2) Two machines—
13,300 watts in the external circuit;
1,800 watts in internal heating of coils;
giving 15,130 watts as the total electrical energy per second.

The power absorbed was 28·53 horse-power, or 21,280 watts, giving an electrical efficiency of 71 per cent.

The electromotive force and current remained as steady as when the two machines had been mechanically connected together by clutches, completely proving that with equal machines such mechanical connections are entirely unnecessary.

This we had also found to be the case in the experiments of October 18th, when experimenting with two machines, and also with the three machines running on the same parallel circuit. The third machine has no mechanical connection with the other two machines, except through the belting, being driven from the same countershaft. When run together, the three machines gave a steady current of 300 amperes through an arc with an electromotive force of 49 volts at the machine terminals, and of 37 volts at the extremities of the arc, giving 11,100 watts expended in the arc.

On account of the high resistance and consequent heating of parts of the lamp, and the irregularity of burning of the 40 millimetre carbons employed, the current from the three machines was only about 25 to 30 amperes greater than the current from the two machines.

The heating of the lamps was, however, greatly diminished by means of a by-pass, suggested by Dr. Hopkinson, from the conducting leads to the lower carbon, whereby a very considerable portion of the current was shunted past the lamp.

In the experiments on November 10th, with the three machines driven independently in parallel circuit, there was considerable variation in the mean electromotive force and in the mean current. The irregularity was due to the very unequal burning of the carbons, which was noticed at the time of the experiments, and not to any irregularity in the working of the three machines; for as the electromotive force increased the current diminished, and there was comparatively little variation in the rate of work done in the arc. In one set of experiments the electromotive force varied from 42 to 32 volts, and the current from 270 to 310 amperes, yet the product remained much more nearly constant, and the average was about 11,000 watts. In another set the electromotive force varied from 41 to 37 volts, and the current from 290 to 316 amperes, giving an average of 11,600 watts in the arc.

The belt was now thrown off the third machine, which still continued at the same uniform speed, being driven as a motor by the current from the other two machines, with the arc still in the external circuit. Thus, of three alternate-current machines arranged in parallel circuit to supply current to an external circuit, one may be run as a motor by the current from the other two, which will continue to supply an arc in the external circuit. The electromotive force at the extremities of the arc and the current through the arc were measured, and experienced wider variations than in the last experiment with three machines parallel, but the power in the arc remained very constant at about 12,000 watts, rather greater than when the three machines were driven directly from the engine. The arc also was observed to be steadier when the third machine was being driven as a motor, as though the motor acted as a governor on the circuit. The electromotive force at the extremities of the arc varied from 52 to 41 volts, with occasional readings outside these limits, and the current varied from 240 to 285 amperes, the electromotive force rising when the current diminished in such a way that the product remained very nearly constant. It would seem from these experiments that the work done in the arc with two machines combined in parallel circuit, without the third machine in the circuit at all, was considerably less than the work done when the two machines were supplying the arc, and at the same time driving the third machine as a motor.

Not only so, but when the machines were all three driven directly from the engine, the work done in the arc was rather less than the work done when the two machines were supplying the arc and at the same time driving the third machine as a motor. These remarkable results are also borne out by the photometric results obtained during these experiments.

With the kind assistance of Mr. Longford and two of my students, Messrs. Anderson and Wordingham, I was able to measure the current, the electromotive force at the terminals of the machine and at the terminals of the arc, as well as the candle-power throughout the experiments. The photometer employed was Dr. Hopkinson's dispersion photometer, in combination with a star disc and a paraffin lamp with a Methven slit which had been standardised, and gave an illumination of 1 candle at the distance of 1ft. Ruby glass and ammonia sulphate of copper solution placed before the eye were employed to compare the intensities of red and blue in the two sources of light. By the Hopkinson photometer an illuminating power of 16,000 candles was reduced to six candles within a distance of 100in. from the arc. The illuminating power given by the arc fed by the current from one machine was measured at a distance of 50in. from the arc, and was found to be, with red light, 8,000 times, and with blue light, 16,000 times the light of one candle.

At the same distance, the current from two machines gave 15,000 candles, as measured by red light. For these and

* Paper read before the Society of Telegraph Engineers and Electricians on Thursday, Nov. 13th, 1884.

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higher candle-powers it was found convenient to remove the dispersion photometer to a distance of 100in. from the arc.

The illuminating powers given by the current from two machines were then found to be 13,500 candles by red light, and 23,200 candles by blue light.

The illuminating powers of the current from three machines driven in parallel circuit were 16,000 candles by red light, and 31,000 by blue light; and when the two machines fed the arc and drove the third machine as a motor, the illuminating power was 17,300 candles as measured by red light.

TABULAR STATEMENT OF RESULTS.

	E.M.F. at the arc.	Current.	Watts in the arc.	Candles.	
				By red light.	By blue light.
With 1 machine....	33	175	5,775	8,000	16,000
With 2 machines {	35·5	275	9,750	13,500	23,200
	36	278	10,000		
With 3 machines {	37	300	11,100	16,000	31,000
	42 to 32	300	11,000		
	41 to 37	310	11,600		
With 2 machines, driving the 3rd as a motor.....	52 to 41	240 to 285	12,000	17,300	

ON THE ELECTRIC LIGHT.*

BY ALFRED RICHARD SENNETT, A.M.I.C.E.

(CONTINUED FROM PAGE 78.)

It will be seen from the diagrams that whilst the addition of reflectors to the alternating-current lights would have a marked effect on the intensity of illumination of ground area, they would be of little service to moderately short arcs, produced by uni-directional currents; and also that the distribution of light from the former is far more uniform than from the latter, especially when very short arcs (such as the Brush) are employed, and the

FIG. 8.

FIG. 9.

arc is not situated far above the horizontal plane to be illuminated.

With regard to the fluctuations in the intensity of the light emitted by the electric arc, with alternating currents, and with uni-directional currents of feeble strength and great electromotive force, the arc is in incessant vibration and motion around the points in its endeavour to pass by the path of least resistance, and in this they present a marked contrast to the fixity of the light emitted from arcs produced by currents of great strength and of small electromotive force working with a moderate length of arc. With a long arc or feeble current the colour of the light is less pure, being more violet or purple as a greater amount is derived from the arc proper and less from the incandescent electrodes. In addition to the greater stability of currents of low electromotive force, the light emitted by arcs produced by them is less influenced by any momentary vacillations of the current or movement of the arc; since, with feeble currents, the electrodes become heated only in the immediate vicinity of the points where the arc leaves and enters them, whilst with powerful currents a comparatively large surface of the electrodes becomes incandescent. Figs. 8, 9, 10, 11, and 12 serve to give a general idea of the appearance of the arc, with various dispositions of the electrodes. In each case the same (powerful) current was employed.

FIG. 10.

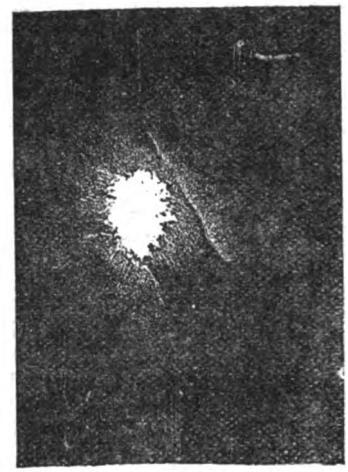

FIG. 11.

Fig. 8 is that of an arc of moderate length.

Fig. 9 represents an arc of the same power, slightly shorter, and with an upper carbon having a diameter 3 or 4 millimetres in excess of the lower one.

In Fig. 10 the front or crater side of an arc having the upper (positive) carbon about half its diameter in the rear of the lower as hereinafter explained.

In Fig. 11 the same disposition as seen from the side (=90° from the preceding view).

Fig. 12 is that of an arc set very short.

It will be observed (more especially in Fig. 12), how very much higher in temperature the positive carbon is than the negative.

For lighthouse purposes the arrangement of carbons already mentioned, namely, when the upper carbon is placed about half its diameter in the rear of the lower, so that its front edge nearly corresponds to a vertical line drawn through the axis of the lower, is generally employed. It is not of paramount importance that a lighthouse lamp should emit its maximum light in a perfectly horizontal plane, since the optical apparatus in which the lamp is situated has the effect of reducing to parallelism all the rays emitted; indeed, by placing the positive carbon below, a simplification of the apparatus is effected, for by thus giving the rays an upward direction, and throwing the chief work upon the upper catadioptric zones, a diminution in the number of lower catadioptric prisms is permissible. For military and naval purposes, however, it is necessary to have the maximum light in a horizontal direction, and for this purpose the carbons (arranged as previously described) are inclined at an angle of 20° with the vertical.

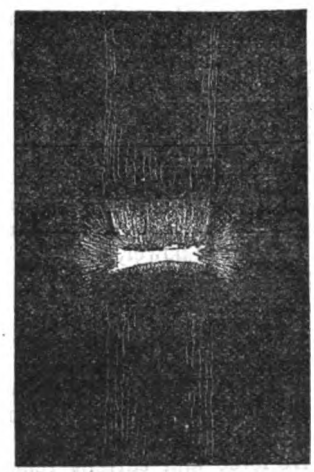

FIG. 12.

(TO BE CONTINUED.)

* Paper read at a Supplementary Meeting of the Institution of Civil Engineers.

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ELECTRIC LIGHTING IN AMERICA.*

BY W. H. PREECE, F.R.S.—*(Concluded from page 69.)*

II.—INCANDESCENT SYSTEMS.

Incandescent lighting in America does not seem to have flourished to the same extent as arc lighting, nor, indeed, has it been applied to private houses to the same extent that it has in England, although there are several central stations at work over there, which is not the case on this side of the water. The principal system in practical use is that of Edison. Some incandescent lamps have recently been introduced by Mr. Weston that promise to be very efficient indeed. They are made from a material that Mr. Weston calls "Tamadine," the result of some secret process upon nitro-cellulose. This tamadine is rolled out into very thin sheets, and the filament is stamped out in a wavy form by dies. It is then carbonised. Carbon is deposited upon this filament until it acquires a standard resistance, and the process self-acting, so that great regularity is maintained in the resistance of the filament. The whole process of manufacture is extremely ingenious, and I watched it in Weston's manufactory with great interest.

The Swan Lamp is extensively used, principally by the Brush Company.

The Bernstein, a new lamp, which was exhibited at the Health Exhibition, is also commencing to get a footing in the States.

House Lighting.—House lighting has been attacked principally by the Edison Company. The Edison Company have a grand central station in New York, which was opened on the 3rd September, 1882, and during the whole of the period that has elapsed from that time to the date of my visit there had been only two and a half hour's stoppage, that being due solely to carelessness. A commodious building in Pearl-street is applied to this purpose. There are now 587 subscribers, using altogether 12,764 lamps, served day and night; and the present arrangements of the Company are quite inadequate to supply all the applicants who desire the light. The price charged is the same as that which would be paid if gas were supplied at 7s. 9d. per 1,000 cubic feet, but there is every reason to believe that the rate is too small, and does not give a sufficient margin of profit. The price of gas is 9s. 2d. per 1,000 cubic feet. It is interesting, however, to know that the system is worked at a profit, and that during the past twelve months the balance on the right side has been sufficient to pay a dividend of 3 per cent. on the capital invested, but no dividend has yet been declared. The earnings per lamp-hour are 1·04 cents, while the cost of production for the same period is ·75 cents. The Board of Trade unit which was intended to form the basis of charges made for the supply of electricity under the hasty and abortive Act of 1882, in this country, was equal to 1,000 watt-power. Now an Edison 16-candle lamp absorbs 80 watts, and therefore 12·5 lamps alight for one hour would consume a B.T. unit. These lamps would cost in New York 15 cents. for that time, and therefore the charge made in New York is equivalent to 7½d. per B.T. unit. The average number of hours of lighting appears to be 2·4 per day per lamp. A record is kept of every lamp, so that the average life is known, and it comes out at about 477 hours. The consumption of coal is ·82lb. per lamp-hour, and there are five lamps per horse-power, rather a low result, due probably to the inefficiency of the old system of conductors. The average number of lamps per subscriber is twenty-one, while the average amount paid annually by each subscriber is £40. The difficulties that have occurred in practical working have arisen principally from a too free use of fuses, which have given much trouble by going when they ought not to go. The conductors have unfortunately been fitted with bad joints, and a good deal of annoyance has arisen from leaks in the mains; but all these effects are due to immature experience, and can readily be remedied in future extensions. The distribution of the currents is carried out by a network system of double mains which involves the use of an immense weight of copper. Dr. Hopkinson in England, and Mr. Edison in America, have shown how an economy of 60 per cent. in the weight of copper used can be effected by using three wires and two dynamos. This system is shown in Fig. 3, and it is now invariably used by Mr. Edison. The whole area of the portion of the city lighted by this system is about a quarter of a square mile, it covers fifty blocks of buildings and fifteen streets, and the capital invested is £200,000. It is intended to open two more central stations, of much larger dimensions, in the upper part of New York, and there is no doubt that with the experience gained, the troubles encountered in the old station will be remedied. At Roselle I saw an interesting installation. This is a small village in New Jersey. There 1,200 lamps were used, supplied by three dynamo machines joined up in series, the lamps also being worked in three series. Overhead wires were used, and the charge was 1 cent. per hour for each 10-candle lamp. This is equivalent to gas at 2·5dols. per 1,000 cubic feet.

Another very interesting central station, wired up on the new 3-wire system, was established at Brockton, a town about 17 miles from Boston. There were 2,090 lamps going, and 1,040 were about to be started. The station was installed in October, 1883, with 250 lamps, and the rate charged was 1 cent per hour for each 10-candle lamp. There were 108 subscribers. The capital of this company is 100,000 dols., 25 per cent. of which belongs to the parent company. The station has not yet carried a dividend, but the expenditure balances the receipts. The business is growing at such a rate that there is no doubt that at the end of the second year a handsome balance will be realised. It is in the hands of a very earnest worker, Mr. W. Lloyd Garrison, who is determined to faithfully test the commercial value of the new illuminant. I also inspected two large central stations in New York, worked on the Weston high tension system. One station worked 384 arc lamps, while the other was working 500 arcs and 1,750 glow lamps. All the details of these two stations manifested the same mechanical skill and solid appearance that I have already alluded to as indicative of the Weston system. In no instance could I perceive sufficient appreciation given to the value of a renewal fund to provide for depreciation. Some estimated the proper allowance for depreciation as low as 2½ per cent., and others at 5 per cent., but in no case did anybody exceed the latter figure. It is very questionable whether this is sufficient to allow for the decay and deterioration of electrical plant, especially of the conductors, which form such a very heavy item in the expenditure in England. I scarcely think less than 7½ per cent. should be allowed.

Conductors.—In all cases throughout the whole of the States, with the exception of the Edison system, the conductors are invariably aërial wires, generally of copper, protected to a certain extent with cotton or hemp covering, and supported by poles fixed along the kerbs of the streets. The high tension currents are always used, and up to the present moment the freedom from danger has been very marked. A considerable amount of trouble has been caused to the telegraph and telephone companies by these powerful electric light currents finding their way into the telephone and telegraph circuits by contacts. I traced no less than seven fires in offices which were undoubtedly due to these causes. The Edison Company have not yet established a central station in Chicago. The chief reason adduced for this is that they have not been able to obtain the consent of the Town Council to place their wires underground, although this same Town Council has ordered all the telegraph and telephone wires to be put underground.

Secondary Batteries.—The use of secondary batteries has not received so much attention in the States as on this side of the water. The form most generally in use is that of Mr. Brush, which is a modification of the Planté cells, and is said to give very good results. Another modified Planté I saw in use at Philadelphia, made by Dr. Starr. The positive plates were composed of a solid frame of lead, filled with thin inverted V plates arranged "herring-bone" fashion, the interstices between which were filled with fine lead shavings. These plates are specially prepared by some process that I did not learn, so as to save the time lost in preparing them as required by the Planté method. The experiments that have been made with the Faure secondary battery were not well spoken of.

Instruments for Measuring Purposes.—The point connected with electric lighting to which I devoted a considerable amount of attention was the practical working of Edison's method of measuring the current used, by the electrolytic action of a small portion of the current upon two zinc electrodes immersed in a solution of sulphate of zinc. In all the central station systems based on the Edison arrangement, this mode of measuring is adopted, and it is said to give reliable results. The measurements are undoubtedly based on accurate formulæ, and if all the conditions are fulfilled, the results must be perfectly true. It is scientifically accurate, and is based on the system used to standardise all current measurers. The bottles containing the solution and the zinc electrodes are collected every month, and, in the Edison district of New York, two men are employed whose sole duty it is to collect and measure these "meters." The plate which has suffered loss of zinc is removed from each bottle of the meter, dried, and carefully weighed. The mean between the two measurements is taken as the true one, and this weight of zinc lost, in milligrammes, multiplied by a coefficient, gives the number of dollars to be charged for the light consumed during the month. The charge made to the consumer, though based on the current supplied, is really charged on the light given, and it is 1 dol. per 1,000 candle-hours. The weight of zinc lost is made equivalent to so many candle-hours, and the subscribers therefore pay for the light they receive and not for the current they use. There are 1,160 bottles out, 50 of which are measured every day. No trouble whatever is experienced in measuring them, and they are unquestionably accurate within 1 per cent., which is more accurate than any existing gas meter. When a meter is taken away for measurement, it is immediately replaced by another one, so that there is no break in the record should consumption be going on. The charges to the consumers are based on these measurements. The consumers themselves have taken various steps to check the reliability of the meter returns, and the result has been that the public has gained confidence in the accuracy of the measurements and the charges made.

ELECTRIC LIGHTING OF SHIPS.

The electric light has been applied to a great extent to the lighting of ships. The great ferry boats of the Pennsylvania Railroad are so lighted. Those magnificent hotel steamers that ply between New York and Fall River, and those on Lake Superior, as well as those on the Mississippi and other large rivers, are either wholly illuminated or are gradually being fitted for that purpose. The fittings on such a steamer as the "Bristol" are very complete, and were carried out by the Edison Company. Special engine rooms are provided for the electric light machinery, and the fittings throughout contain all the most recent improvements, and form a very admirable installation. All the great passenger steamers crossing the Atlantic are being fitted, and the comfort of the passengers in consequence is inestimable.

GENERAL COMMERCIAL POSITION.

The problem as to whether electric lighting is practical, and as to whether that means of illumination can be made to pay, has been thoroughly solved in the United States. The great mistake that has been made there, as it has been made here, has been the attempt to enter into competition with gas. The Edison Company started on the basis of the charges made for gas, and the result of the two years' working has been to show that this was a financial mistake. Electricity must earn its future success entirely upon its merits and not on its economy. In the case of street lighting it has proved itself to be a good thing, and if once a thing is proved to be good in America, it is immediately taken up; "Progress" in that country is the word. Novelty is a certain criterion for consideration. Manufacturers do not hesitate to clear out their entire factory if they find that they can get cheaper and better work by entire renewal. So with the electric light. If it proves

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itself (as it unquestionably does) to be a better light than gas, then gas-fittings will be instantly removed, and electric light fittings substituted, without particular reference to the cost, so long as it is reasonable and within the means of the consumer. I have said more than once that at the present day we can only regard the electric light as a luxury, and we must pay for it as a luxury. But there is no reason why it should always remain a luxury. There are various chances of economy which justify the conclusion that, sooner or later, the price will be brought down so as to relieve us of the use of the term luxury as applied to it. For instance, the output of the dynamo can be extended, which has already been done with several types, particularly, as I have pointed out, in the case of the Brush pattern, where 60 arc lamps are now lighted where only 40 lamps were supplied by the earlier and unimproved machine. Again, considerable reduction in the weight, and therefore in the cost of the conductors, has been reduced by the production of the three-wire system. Moreover, when existing patent rights lapse, the manufacture of dynamos will become general, and the consequent competition will no doubt result in the production of efficient machines at a sum far below the cost of those made under existing patent rights. The efficiency of the glow lamps has also been very considerably affected by the improvements made, for instance, by Messrs. Woodhouse and Rawson, and by Mr. Bernstein. The efficiency of the Edison lamps means the consumption of energy at the rate of 5 watts per candle with an equal life, but lamps are now being made which give an efficiency of 2·3 watts per candle, which is equivalent to an immediate reduction of 50 per cent. in the amount of energy required to maintain the system alight, and therefore at the cost of its production. There is still vast room for economy, and it is quite clear that the prices which are now necessary to make the electric lighting pay must not be regarded as final; they will be brought down. Even now it is possible in England to make a system pay at the rate of a halfpenny per glow lamp per hour; and no one who has ever experienced the charm and comfort of the electric light, and who has electricity brought to his door, and supplied to him at this rate, would hesitate to pay that figure for the use of electric lamps, although he could obtain the same light by gas at less than half the price. There is a point that will lead to the introduction of the electric light that is very marked in the United States—viz., its influence, when applied to the streets, upon the the morality and safety of the public. The Chief of the Police of New York has gone so far as to say that "every electric light erected means a policeman removed." This, though probably got true as regards actual numbers, is so far true in fact, that the supervision of the streets and thoroughfares is rendered far simpler when they are brilliantly illuminated by the electric light. Its moral effect is principally to be noticed by the way in which it has checked the formation of crowds, and disturbed the haunts of those who, unfortunately, infest most great towns and cities, and who render the streets of London at night a disgrace to modern civilisation.

COMPANIES' MEETINGS & REPORTS.

The Swan United Electric Light Company (Limited).

The second ordinary general meeting of this Company was hold on Wednesday at the Cannon-street Hotel, Mr. J. S. Forbes in the chair.

The SECRETARY read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: I shall trouble you with a very few remarks. I am very sorry to see so small an attendance of shareholders. I wish they would come here themselves instead of sending their proxies. A great number of shareholders have been good enough to send their proxies, representing about 35,000 shares, but it would be much more satisfactory if people really largely interested would attend the meeting and assist the Board. However, we must take it for what it is. The report we have made as full as possible, in order that you may see without any very long story from me what the position of the Swan Company is. In respect to the asset involved in what is called the foreign patents, a good deal of what I should have said on that is rendered unnecessary to-day by the preliminary meeting of the people associated together—now happily, I think, associated together—in the Edison and Swan Company. We had there a very long story; we had a good deal of criticism, and we came to a certain conclusion. The Board, in whom for the present the shares of the Edison and Swan shareholders are vested as trustees, announced their perfect readiness to retire if the proprietors think fit, or to carry on the business to a conclusion if the proprietors think fit. Now, we did not think it seemly to take any resolution at that meeting; we thought we would wait the issue of to-day and of an Edison meeting, which I suppose will follow, and hear what the general view of the proprietors is. I had better just explain what the position has become. Of course there are a great number of wise people who can always prophesy after the fact, but who, not knowing very much about it, having very little sense of the facts, can always put everybody right, and can tell you that everything that has been done has been wrong. We are quite satisfied that to fuse with the Edison Company was a wise thing to do; and having fused we must make the best of it. But it places the members of the Swan Company in a rather difficult position as regards the existing Edison and Swan Company. They have no legal vote at present, nor can they have until they have got possession of the shares of that Company, which represent their interest in that Company. They can do what ordinary shareholders under the Articles will do, elect or reject; in fact, have the control of their own business. Until then they must be satisfied to be in trust, and I think it will turn out that this is a very good thing for them. We shall see. With respect to the other asset, that covered by what is callled the foreign patents, it is competent in the Swan proprietors to act, and you will find that this balance-sheet and statement refers exclusively to the business conducted under that part of the affair. Now, I had better just in a very few words tell you where we are. If you will cast your eye upon that balance-sheet you will find that it is one to the end of the year ending 30th June, 1884. You will find there what the share capital of the original Company is—19,750 shares of £5 each fully paid and 80,000 shares of £5 each upon which £3 has been paid; that represents £339,200 in round numbers. Well now, under the fusion with the Edison and Swan Company we could only put in a portion of the business, to wit the British business, and in respect to that partnership the shares in the new company were divided in certain proportions—a matter of agreement, not done without consideration or a certain amount of knowledge of the affairs of both companies, and upon a principle which I explained very fully the other day, and I do not think I need go over the ground again, because every proprietor had the report of the United Company sent to him. I suppose every proprietor has by this time received a report of the proceedings. I took the opportunity of stating the matter very fully then, and I think I stated it as clearly as it could be stated, and in language so plain that I think anyone using ordinary comprehension could understand perfectly the story. We have in that Company a certain number of shares alloted to us. We took in respect to the British interest so many paid up shares and so many shares that at that time had £2 10s. paid upon them, and we shall have to deal with the capital account of the Swan Company upon that basis. You now, instead of having one share in the Swan representing a united interest, have a share representing a partnership in one undertaking and a separate asset in another, and as nearly as figures will bring it out it is something like this:—We have 61·46 per cent. in the United Company, and, of course, the balance, 38·54 in the separate asset. Well now, what are we to do with this separate asset? Of course the Swan proprietors of the Swan, when the shares of the United Company are distributed, will be proprietors to that extent of the United Company. They will remain proprietors of this separate asset, and the only practical way to deal with it will be to devise some means by which the present share shall be split—the shares of the United Company distributed in respect to the 61·46 and some other instrument or share in some other form must be created to represent this foreign business. That is the skeleton of the future thing. Well, we have considered what should be done with the foreign business. Is it to be carried on or fused with the United Company? There are some arguments in favour of fusion, and some against it, and the latter prevail. A fusion would raise questions of some gravity and some difficulty in respect to the interest of the Edison proprietors in the United Company, and especially in regard to the deferred interest which Mr. Edison holds in that company, because, as I explained, whereas the patents of the Swan Company had been bought out and out either for money or shares—a very unwise proceeding as it has turned out—I think Mr. Edison's patent was represented by deferred shares, and we had a good deal of difficulty in bringing Mr. Edison to terms in respect to his deferred interest when the British interests were fused. I think we should have a good deal more difficulty to bring him to terms in respect to the foreign patents, because he has sold them to other people and has no interest in them, and as a man of honour might feel some difficulty in being a party to the transfer to his own company here in England of a business abroad, which may be, and probably will be, in severe conflict with the interests of the people from whom he has already received consideration. At all events, we determined the proper way would be to carry on the foreign patents and foreign business as a separate asset of this Company—that is to say, if there is a reasonable probability of these patents turning out to be worth anything, and a reasonable probability of the business being conducted to a profitable result. That being the policy we have to consider, I shall come presently to a resolution I shall have to propose on that subject. Meanwhile, having reminded you that you are here to-day dealing with this report and this balance-sheet merely with the state of the foreign business, or with the separate Swan Company, I do not know that I have very much to say, the report is so very full. We thought it desirable to make it as full as possible, in order that shareholders may not only be able to draw from it what information they can, but what comfort they can. The best, I think, that can be said of it is that it is less bad than the report of the United Company, as showing that the loss on the working of the thing has been less considerable. But the very same reasons which I adduced in explanation of the state of things which I had to bring before the proprietors a few days ago hold good. In fact, more than hold good, because, first of all, the business is spread over a much wider area than the British patents, and had to be conducted much more cautiously and with more difficulties, legal and otherwise, and it is the same story, on all fours as to the difficulties at home, where we were led to fusion in order to escape litigation. We are in litigation in half-a-dozen cases, and until that litigation is terminated it would be very unwise to commit ourselves to any very large expenditure of money in forcing these patents and doing this business abroad. Still, we are sufficiently far advanced to have thought it desirable to make a start. The report will tell you what has been done; it explains why the financial result on the profit and loss account is not very satisfactory. But the truth of the story is that until you get this business founded the fixed expenses must bear an enormous proportion; in fact, must swallow up the first fruits of a small business. The only thing to arrive at is this:—Is it a business that will grow? Will the volume of it be so increased as to reverse that state of things? Well, we think it will; and because we think it will, and because some of us are largely interested in the matter, we have made up our minds to prosecute it. I think I may say I am speaking the feelings of those around me when I say that we are all agreed that this foreign business is a good business, which offers certainly quite as good a future as the

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English business, if not a better. Well, if that be so, what is to be done? What we should recommend you to do is to carry it on. We have established factories at Lille and Cologne. We are in litigation in two or three places, notably at Cologne. One can never tell abroad, as in England, what the ulimate result of legal proceedings may be. I think we have drawn first blood—at all events we have a technical decision in our favour to this extent, that whatever may be the merits of the Swan patent, it is not an infringement on the Edison patent, because that is what they are fighting about abroad. Whether that view would be maintained at home one does not know; one never knows the result till judgment is given. We thought it wiser here not to provoke that judgment. I do not know whether the Edison people abroad will be induced to do what the Edison people at home have done and what we did—put their horses together. If they do not we must fight on in the sense of defending an attack. It is defensive fighting. In the face of all that, notwithstanding the bad result of this balance-sheet, notwithstanding the very large sum of money paid for these patents, our opinion is you will be wise to go on, and not to throw up the sponge upon the result of the first year or two's business. Of course everybody has been a little disappointed. Plenty of people can prophesy after the fact. The world was a little mad about the electric light a short time ago, and I am not sure they are absolutely saner now, and when your bargain was made no doubt you paid too much, but without indulging in prophecy, bad as it stands on this paper, I do not think the amount paid or the sum of money invested is so very appalling as to induce people to draw back without spending a little more money. No doubt it is a very bad policy to throw good money after bad, but sometimes it is done to get good money back. And that is what we shall recommend you to do—to go on with this thing. Well, then you will see what the result of it all is. There is a great demand going on for these lamps, because after all, as we said before, that is the best part of this business. If we can limit ourselves to the manufacture of lamps, and if we can find a business and maintain a sale in sufficient volume of these lamps, we have a good factor for a profit on all the money sunk, even supposing we should have to give up installation work or public lighting. Well, I do not think we need do that. I believe in the future of this Company. Both here and abroad there is a great deal of useful installation work on which a large profit may be made, but for the present we think it would be wise to limit ourselves as much as possible to lamps and that class of installation work which means ready money for what you do. I do not think we shall be easily tempted out of that path, and if we continue it with reasonable care, in the opinion of the Board there is no reason to doubt that, notwithstanding our position, which does not look very satisfactory now, about which I see some people howl a little, and take a gloomy and desponding view, as people always do in that frame of mind—ignore palpable facts, strain inductions, and generally make a mess of it—notwithstanding that, I think we shall get through. Now I have no doubt there are some critics in the room, because I see the mover of an amendment which was made the other day at the meeting present. I should like to hear what those critics may have to say before I make any further remarks, and if it is deemed expedient to give information I shall be very happy to do so; but, meanwhile, I shall move the resolution that the report and accounts be received and adopted.

General TREVOR seconded the motion.

Mr. BALFOUR said there must have been mismanagement on the part of the Directors, the Chairman, the Managing Director, or someone whom they employed, or the Company could not have drifted into such an unsatisfactory state. Twelve months ago the price of the shares, with £2 10s. paid, was £1, but now with £3 paid it was only 1s. 6d. to 2s. 6d. He said that in July, 1882, several of the Directors reduced their holding of shares to their bare qualification, and argued that from that fact the Board at the time must have known that the Company was not going on in a satisfactory manner. He thought they should demand a pledge from their Directors that no further call should be made without calling the shareholders together, to tell them in what manner the money was to be spent. He thought also that like every other Company they should meet twice a year; and he suggested that the retiring Directors should not be re-elected, and that a committee of ten or twelve large shareholders should be formed to recommend three gentlemen for a seat at the Board.

Mr. KEMPSTER moved the following amendment:—"That in the opinion of this meeting it is not desirable to adopt the report and accounts now presented; but this meeting would urge the shareholders to combine for the protection of their property, and to this end would seek the active co-operation of the large and influential shareholders, by whose aid it may be possible to control the management of this Company and the Amalgamated Company; and this meeting is of opinion that no fees should be paid to Directors except out of the profits of the said Companies." He thought that if a resolution of that kind were adopted it would have a moral effect, and the shareholders who were absent and had sent their proxies would see that the gentlemen in London, who had had the opportunity of discussing the matter, were not quite so simple as themselves. He thought they should have a poll taken in order to see who were the persons who supported the Board, and although they were told they could pass no legal resolution he thought the adoption of his amendment would have a moral effect. There was great reason why the report should not be adopted, because if it were the shareholders would be told that they had endorsed and approved everything that had gone before; therefore, he solemnly warned the shareholders not to adopt the report and balance-sheet. There were sufficient grounds for suspicion that all was not right. They had heard of the enormous sums of money paid for patents, and it had been suggested by one of the financial papers that those large sums of money had never found their way into the pockets of the two gentlemen to whom they should have been paid—Mr. Swan and Mr. Edison. That was a very serious statement, and they ought to be thoroughly assured that it was absolutely false if it were so. If that money had gone into the pockets of any people who occupied a fiduciary position they were entitled to have it back. Twelve months ago the Chairman said that if at the end of a year they found their capital intact that would not be a bad outcrop; and if the Chairman did not know then that they were on the horns of a dilemma he must have been incompetent. Mr. Forbes also said that he believed that they had arrived at the threshold of a grand future, and they must now carefully feel their way—did Mr. Forbes at that time believe that?

The CHAIRMAN: I did believe it, and I do believe it now.

Mr. KEMPSTER continued that at the meeting last year the shareholders had the distinct assurance that the Directors would not make a call unless the money could be profitably employed; they had made a call, and the money had not been profitably employed. He contended that they were virtually in the hands of certain large shareholders, who were either the promotors of the Company or who had been connected with the promoters.

Mr. SWABY seconded the amendment.

Mr. LEYLAND said that the Company was in a critical condition, and it might result seriously if they attempted to interfere with the present management. However, he suggested that now the Directors had determined to take steps for the distribution of the shares.

Mr. QUILTER was very glad that Mr. Kempster had had the boldness to attempt to substantiate the hints that had been thrown out in the articles of that very "independent financial paper," because it enabled him to give a few statements which would at once and for ever, he thought, set at rest in their minds any suspicion that there had been anything in the formation of this Company which any committee of investigation, no matter how hostile, could say was not straightforward and satisfactory. The preliminary expenses amounted to £624 10s., which sum included the commission to the brokers, none of which money was paid to himself. The only payment he received was a fee from Mr. Swan at the time when he undertook the formation of the Company, and he took shares to three times the amount of the fees he then received, and he now held those shares. That showed his faith in the Company. He now fully shared the faith of the Chairman, and still believed that with good management the future of the Swan was a promising one. He stood now to lose five times the amount of the fee he had received, and he believed that about a third of the shares of the Company were taken by his own friends, and a very large majority of those shares were now held by them. Mr. Crompton had received every penny he was entitled to. Mr. Swan had received every penny to which he was entitled, and therefore he had great pleasure in saying that there was not a particle of truth in the insinuations that had been alluded to.

Mr. STEVENSON, M.P., said that when the Newcastle Company was transferred to this undertaking he invested the whole of the money he got for his shares in that Company in the shares of this Company.

Mr. LEDGER asked the Chairman how many times he had attended the meetings of the Board of the Swan Company. He put that question with all due respect.

The CHAIRMAN replied that he declined to answer. He would decline altogether to enter upon any personal matter.

Mr. LEDGER: I wish to show the interest you take in the Company.

The CHAIRMAN: It shows how very little you know about the matter.

A SHAREHOLDER said that Mr. Forbes was undoubtedly a most able man, but he thought they should know what attention he had paid to the interests of the Company.

The CHAIRMAN said that if they would like to know, since the Swan Company proper transferred its business, the most complicated and the most difficult to the United Company, he had been most assiduous in his attention to that part of it. It was most difficult and involved. He doubted if any gentleman in that room had any knowledge of its perplexity or difficulty. He thought he might claim for himself the credit of having been the chief means of bringing about the fusion upon terms which he regarded as most favourable. With respect to the business of the Edison Board, they had met no doubt a great many times *pro formâ*, but they had no control of any kind with the manufacture of business in England. They had a competent Managing Director in Mr. Stearn, and he thought if the Swan Directors were wise they would leave Mr. Stearn alone, and not interfere too much with him. But if it were supposed that attendances at formal meetings were a measure of a man's knowledge or capacity to conduct an affair he begged to say it was not. Fortunately he was associated with gentlemen who would be able to form a correct opinion as to whether he had or had not discharged his duty. He had a great interest in the Company, and he was quite satisfied himself with what he had done in the Swan Company and the Swan United.

Mr. LEDGER: That is not answering my question. I asked how many times you have attended at the office.

The CHAIRMAN: I cannot tell you. If you ask how many times I have been in the office—a great many times.

Mr. QUILTER said that he had been entrusted with a large number of proxies, and thought it would give satisfaction if some of the largest shareholders were to confer with the Board. Many large shareholders felt that they ought to be more directly represented on the Board. He appealed to Mr. Kempster to withdraw the amendment.

The CHAIRMAN asked if Mr. Kempster desired to press the amendment.

Mr. KEMPSTER said that he must press it, as he wanted to test the feelings of the shareholders.

The amendment was then put and lost, 14 voting in its favour.

The resolution for the adoption of the report was then put and carried.

Mr. KEMPSTER demanded a poll, but in deference to the general wishes of the shareholders the demand was withdrawn after some discussion.

The CHAIRMAN said that the next question was the re-election of Directors, and if anyone was particularly anxious for his seat he was perfectly welcome to it. With regard to the statements that had been made in a certain paper, all he could say was that they were absolutely untrue, and the inferences were absolutely untrue, and they must have been

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written for some dastardly purpose. Mr. Kempster's arguments had been based on a total misunderstanding of the nature of the Company. He had exhibited an entire ignorance of the A B C of this Company; he did not even know the nature of the agreement between this Company and the Edison Company, and wanted light upon that which the most casual perusal of the agreement or the most superficial knowledge of the Company would have given him. Mr. Kempster was very much in doubt as to what the position of the proprietors was as to calls, but he need not have been, for he could have come to the office and asked him (the chairman) or anybody equally competent, and all his doubts might been dispelled. With regard to the protest that had been issued he did not think it was worth while to comment upon that except to say that it was mere stuff. It was a very long-winded protest, without the shadow of foundation in it, and was issued no doubt to damage the interests of this Company. He did not think it was worth while dealing with it. Any man who took for his text the vilification of individuals ought not to be listened to, and he considered that all men who did that ought not to be answered. That was his opinion about them. If the proprietors of this Company considered that his resignation would do their concern good, in heaven's name let them discharge him; because it was quite enough to have the responsibility and the serious wear and tear attached to the administration of the concern; but if in addition to that the Board were to be attacked in a scandalous manner it was an atmosphere no gentleman cared to live in. He was not, however, going to be forced out of his seat by a cabal. Men of the first position had trusted him in this as in other things, and he had always been faithful to them till he had pulled them out of their difficulties, and that was what he was going to do here. He was not going to be hounded out of the chair by those who had no real interest in the Company.

Mr. SWABY: I have spent £900 in this Company.

The CHAIRMAN: Well, spend a little more.

Mr. SWABY: That I decline to do.

The CHAIRMAN could not help it; he could only advise Mr. Swaby to buy more shares. He was not going to be hounded out of the chair by gentlemen who had no knowledge and nothing but angry feeling. He was not going to be hounded out of the chair as long as he had the confidence of the large proprietors, who were legally and, what was more, morally entitled to control the thing, and as shareholders were utterly incapable of acting for themselves in matters of this sort, they must trust somebody who would act for them. He would act for them if he could, and if he failed, then let the people who had a solid interest in this concern invite him to retire, and he would not fail to do so. He had a great many other things to do besides looking after this Company. With regard to the price of the shares, he did not think that that was a true index of their real value, and why people should be such idiots as to sell their shares for 2s. he could not imagine. They had substantially all now that they ever had, and he believed they were in just as good a position as ever they were in, if the original purchases were justifiable. With regard to the re-election of Directors, if the shareholders wished it they might postpone the consideration of that question in order to find some one who had a large stake in the concern, and who had a right to a seat at the Board, but as to a committee of investigation or anything as a means of getting on the Board he did not mean to submit to it.

After some further discussion it was resolved that the consideration of the re election of the retiring Directors should be postponed for a week.

The CHAIRMAN said that the Directors wanted the shareholders to call upon them to take the necessary steps to distribute the share certificates, and he therefore moved—"That the Directors be requested to take the necessary steps for distributing amongst the shareholders the shares of the Edison and Swan Electric Light Company (Limited)."

General TREVOR seconded the motion, which was carried.

A vote of thanks to the Chairman then terminated the proceedings.

Great Western Electric Light and Power Company (Limited).

An extraordinary general meeting of this Company was held at the Cannon-street Hotel, on the 8th inst., for the purpose of considering, and if deemed advisable, of passing the resolutions referred to in our last issue. Mr. J. B. Braithwaite, jun., presided.

The SECRETARY (Mr. H. P. Allender) read the notice convening the meeting.

The CHAIRMAN said that before he made the short statement which he proposed to make on this occasion, he thought it would be a convenient course to adopt if he asked their solicitor, Mr. Crisp, to give them a short substance of the provisional agreement which it was proposed to approve, or otherwise, at that meeting.

The SOLICITOR accordingly mentioned the salient heads of the agreement, which he said was dated the 28th ult., and it was conditional on its being approved by the shareholders before the 23rd inst. The fifth clause would be the one to receive the principal consideration of the shareholders. It was as follows:—"As further consideration, the liquidators shall, within fourteen days after the passing of the special resolution for winding-up the Western Company, pay to the Directors of the Western Company, out of the cash belonging to the Western Company, a sum of money equal to 10s. in respect of each share upon the written personal undertaking of the Directors to apply such sum of money in payment of a dividend of 10s. per share to the shareholders in the Western Company on each share held by them; and in addition to such payment as aforesaid each member of the Western Company shall be entitled to require the Brush Company at any time within three calendar months from the date hereof, to allot to him three fully paid-up £5 shares in the Brush Company in respect of every twenty fully-paid shares in the Western Company held by him." There were some provisos as to how the requisition was to be made, as to fractional certificates, and as to paying any dissentient member. The Brush Company were to accept without investigation such title as the Great Western Company had to all their property. If not approved before the 23rd instant the conditional agreement would become void.

The CHAIRMAN said it would not be necessary for him to detain them for many moments on that occasion, as he trusted that the substance of the agreement, as stated by the solicitor, combined with what the Directors had stated in their circular, would have made the terms of the proposed amalgamation quite clear. He might mention in the first place that when they last met about two or three months ago they little thought they would have so soon to meet the shareholders again, or have any proposal of the nature then before them to submit. It was about a month or six weeks ago that the Brush Company made overtures to them, and inquired on what terms they would be prepared to make over the Company to them, and the result of the negotiations was the offer before them. The Directors tried to draw up their circular so as not to bring any pressure on the shareholders in any direction, as they wished to leave it to them to decide whether they would accept the offer or not. They had, however, received proxies to be used against the proposal representing 334 shares, and proxies to be used in its favour representing 14,509 shares; and in addition they had received the concurrence of Mr. Edwards, the liquidator of the Devon and Cornwall Company, that he agreed to the amalgamation on behalf of the 3,000 shares to be allotted to that Company. That represented about 18,000 shares in favour of the amalgamation out of a total of 27,800. Two or three of the shareholders had written under the impression that the fully paid-up Brush shares they were to receive were £10 shares. That, however, was a mistake, as the capital of the Brush Company had been reduced by one half, and it was therefore £5 shares which they would receive. The direct value of the offer made was as follows:—They had 28,618 shares, including those to be allotted to the Devon and Cornwall Company. The Directors had reserved to themselves the right to distribute among the shareholders the bulk of the cash in hand. The amount would be practically £14,000, or 10s. for every share held. Each shareholder would also receive for every share he held 15s. in fully paid Brush shares taken at par. The present market price of the Brush share was 3½, so that at the present market price of those shares the shareholders would receive altogether £1 0s. 6d. per share held by them in this Company. Looking at the balance-sheet, supposing they went into liquidation they would not be able to give the shareholders as good a return as that. Looking at it from every point of view, and that there was a prospect for electric lighting, he thought the shareholders had done wisely in electing to accept the offer, as they would receive shares in a company which was solvent and in a position to carry out its contracts. The Directors felt, after taking office as they did to try and rescue the Company from the wreck it had been about to be involved in, that they ought not to hand it over on any principle of taking shares in the Brush Company unless their position was sound. He and Mr. Reynolds, therefore, had a long interview with Lord Thurlow, the Chairman of the Brush Company, and the whole position of that company was laid bare to them. They asked all the questions which the shareholders would know would readily suggest themselves on such an occasion, and they were answered in the fullest and frankest manner. With those answers they were quite satisfied; and on the strength of that interview they were there to say that they thought the shareholders had acted very wisely in giving the Board such a large majority as they had in favour of the proposal. It should be borne in mind by the shareholders in considering this offer that while the capital of the Brush Company had been reduced to one half of its original amount, the capital of this Company remained the same; and therefore every £5 share which they were going to get of the existing Brush Company was equal to £10 of their stock as it was when it was started; so, assuming that they were back in those days, the shareholders would get 30s. instead of 15s. in the shares of the Brush Company, and 10s. in cash, thus representing £2 of the original £2 10s. He concluded by moving *en bloc* the resolutions above referred to.

Mr. STEWART briefly seconded the motion.

Mr. BACKHOUSE said he wished to ask a few questions; and, first, the Chairman had stated that there were 27,000 odd shares. According to the last report, however, there were 24,744 shares, and 3,000 had to be given to the Devon and Cornwall Company. This made 27,000 odd; but off that number had to come the number given by the Brush Company for the purchase of certain rights from the Company.

The CHAIRMAN said that if Mr. Backhouse looked at the balance-sheet he would see that the 1,150 shares which they received from the Brush Company had been deducted from the amount of the capital before the amount mentioned by Mr. Backhouse had been reached.

Mr. BACKHOUSE said he presumed that it was open to the shareholders to move any amendment.

The CHAIRMAN: Decidedly.

Mr. BACKHOUSE said he would move "That the offer made by the Anglo-American Company be refused." He happened to be in Manchester last week, and made some inquiries as to the electric light and the progress it was making, and also about the Brush Company particularly. He was fortunate enough to meet with a gentleman who had a great deal to do with electric lighting, and he heard that it was spreading very much, and that the Victoria lamp of the Brush Company was acknowledged to be one of the best in the market. The offer which they had met to consider had been made unexpectedly to the Directors. He thought from their circular that they had considered the matter in a strictly impartial light, but he now gathered from the remarks of the Chairman that he was quite of opinion that the shareholders of the Company would be right in accepting the offer. According to the balance-sheet last presented to the shareholders the Company had over £16,000 in cash. He had thought

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that the Chairman would perhaps have stated what the amount of cash was at the present moment, and whether much of the sum mentioned had been lost since the meeting. Taking it roughly that there was something like £16,000 at the bank, and that the face value of the land and other assets was worth £13,700, the Company had altogether about £30,000 in cash and property, which the Brush Company would get. For that £30,000 they offered this Company £12,700 in cash, and of that over £1,800 would go to the Brush Company, so that the whole of the cash they would pay this Company would be about £11,000.

The CHAIRMAN stated that the amount of cash the Company would receive was £13,900.

Mr. BACKHOUSE, continuing, said that in that case the amount would be reduced in a similar manner to £12,000. The whole of the cash the shareholders would get would be £12,000 for the £16,000 they possessed; and for the plant, &c., possessed by them they would receive the face value in shares of the Brush Company. For their patent rights, however, which they purchased two years ago of the Brush Company, they would get nothing. He believed that over £20,000 was paid by the Company to the Brush Company for those rights, besides £15,000 in shares, and they would get not a single farthing in consideration of this. He happened to know that an offer had been made by the Brush Company to buy up another of the subsidiary companies. Knowing that the Victoria lamp made by the Brush Company was admittedly one of the best, and believing that the prospects of the electric light were better than they had ever been, it seemed strange that the Brush Company should ask the shareholders of this and other subsidiary companies to surrender for nothing whatever the rights for which they had paid three-fourths of their capital. Whichever light the offer was looked at, it seemed to him to be an extraordinary one. In their last report the Directors stated that the Brush Company had given them back 2,300 of their shares in the Company for the right to light up railway trains in the district of the Company. They made the concession believing in the value of what they acquired. When the Devon and Cornwall Company was wound up 3,000 shares were given to them. How was it that they were proposing to deal with the Brush Company in a totally different manner from that in which they had dealt with other companies connected with them? The proposal seemed to him to be outrageous and unfair. If Brush shares were given to them to represent the £20,000 in hard cash which had been paid by them to the Brush Company, it would be some acknowledgment for the rights which they were now asked to give up for nothing. With regard to the shares of the Company held by the Brush Company, it was, he contended, monstrous that those shares were not surrendered. Whatever money was divisible ought to be divided among the shareholders of the Company. It seemed to him a most one-sided offer, and he trusted that no shareholder would sacrifice his property for about half its value. He moved that the offer be refused.

The SOLICITOR: That is not an amendment. It is a negative.

The CHAIRMAN: That is a direct negative.

After a few observations from Mr. Heath,

Mr. WATERS pointed out that in accepting the Brush shares they were accepting shares in a company the original value of whose patents had been wiped off. The shares were thus really double their existing par value.

The CHAIRMAN, in reply, said he thought, as Mr. Waters had pointed out, the remarks of Mr. Backhouse rested on a misconception. He was not there to urge the shareholders to adopt the offer. In sending out their circular they abstained from making any suggestion, but after the very large preponderance of votes which they had received through the proxies in favour of the offer, he felt it his duty to carry out the wishes of those shareholders as far as possible. Mr. Backhouse seemed to have lost sight of two or three very important facts. He had lost sight of the fact which he (the chairman) and Mr. Waters had called attention to—namely, that each Brush £5 share represented £10 of the original capital of that Company, so that if they were to go back to the time of their concession they would be getting by the offer 30s. instead of 15s. in Brush shares. As to the amount of cash at the credit of the Company, it was very much what it was when their balance-sheet was issued—between £16,000 and £17,000, with their debts, and the bulk of this they would distribute to the shareholders. The remainder—it was a small amount—they thought it only right that the Brush Company should have, as two stations would be handed over to them—Bristol and Cardiff. According to their last balance-sheet, their property and plant and cash represented £30,000, and in exchange for that, taking the Brush shares at their par value, they would receive £34,740, so that the effect was to liquidate the Company at their own valuation, without any of the costs of doing so. He was very glad to hear Mr. Backhouse testify to the excellence of the Victoria lamp; and it was on that fact, their excellent incandescent lamp, their prospects of business, and the result of their eight months' work that the Directors went. He could not but think that they would be very wise in accepting the offer which had been made. As to Mr. Heath's question respecting the case of the Devon and Cornwall Company, the Great Western Company had a claim made against them amounting to £29,000. That claim would have made them entirely bankrupt, and had they fought it out in the courts of law it would probably have involved them in very heavy expenditure. They therefore made an arrangement which was thought fair and equitable on the whole to both sides. The present case was of a very different character. They were not bringing an action against the Brush Company, but that Company had come and asked them on what terms they could go into amalgamation with each other.

A SHAREHOLDER asked what remuneration it was proposed to pay the liquidators.

The CHAIRMAN replied that no arrangement had been made, but the question did not affect them, as the expenses would fall on the Brush Company.

Mr. REYNOLDS stated that he would accept no remuneration whatever. He would be only too pleased to help the Brush Company and to assist them in their business, which he thought this Company had done a good deal to help on.

The CHAIRMAN repeated that the Brush Company would pay all the expenses of the liquidation of the Company. They made it a strong point that one of the Directors of the Company should be a liquidator, and that they themselves should distribute the cash to the shareholders. He then put the motion, which was carried, there being only three dissentients. It would, he afterwards stated, be necessary to hold a confirmatory meeting, which would take place that day fortnight.

A vote of thanks to the Chairman brought the proceedings to a close.

Brush Midland Electric Light and Power Company.

The ordinary and extraordinary general meetings of the shareholders was held at the City Terminus Hotel, Cannon-street, on Tuesday; Mr. R. H. Glyn in the chair.

Mr. H. N. MYERS (the secretary) read the notice convening the ordinary meeting. The report and accounts were taken as read.

The CHAIRMAN said the shareholders were aware that two meetings had been convened; the first a merely formal one, to pass the accounts; the second a more important meeting, to consider the amalgamation of this Company with the Anglo-American Brush Corporation on the terms which had been submitted to the shareholders. He had very little to say with regard to the accounts, except to point out, as the shareholders had doubtless seen for themselves, that on the working of the year there had been a loss of about £1,000, although the expenses had been kept as low as possible. The only thing they could say was, that under the circumstances they were thankful that the loss was not larger. Unless the shareholders wished to ask any questions on the accounts he would suggest that they should be passed, and that they should then proceed to the business of the extraordinary meeting, to which he would refer more particularly. He formally moved the adoption of the report and accounts.

Mr. RUSSELL EVANS seconded the motion.

Mr. STOKES asked what was the position of the arrears of calls?

The CHAIRMAN replied that he would go into the matter at the extraordinary meeting.

A SHAREHOLDER said the shareholders agreed a year ago to give the Company a further trial, and unfortunately the trial had not proved successful. Under these circumstances he thought the Directors' fees and the salaries paid were too high.

The CHAIRMAN pointed out that under the Articles of Association the Directors were entitled to take £1,000 per annum; but they had only taken half that amount. The salaries had been kept as low as possible.

The motion was then put and carried unanimously.

The SECRETARY then read the notice convening the extraordinary meeting, which was called "for the purpose of considering, and, if approved, of confirming a provisional agreement made the 29th day of November, 1884, between this Company of the one part and the Anglo-American Brush Electric Light Corporation (Limited) of the other part, referred to in the report of the Directors of this date, and should such agreement be approved, for passing a special resolution for winding-up the affairs of this Company voluntarily, as the means of giving effect to the said agreement."

The CHAIRMAN said it would perhaps be advisable that at the outset the solicitor should state the effect of the provisional agreement into which the Directors had entered, subject to the approval of the shareholders.

Mr. GEORGE DAVIS (the solicitor) said the provisional agreement was dated the 29th November last, and was made between this Company and the Anglo-American Brush Electric Light Corporation (Limited). The first part of the agreement provided that the Midland Company should sell practically the whole of its assets to the Anglo-American Brush Corporation, and that as part of the consideration for that sale the purchasing corporation should satisfy all the obligations of the Midland Company; and there was this further consideration, that each member of the Midland Company should be entitled to acquire from the Anglo-American Brush Corporation at any time within six months of the date of the agreement four fully-paid up shares of £5 each of the Anglo-American Brush Corporation for every twenty-seven shares of £2 10s. each in the Midland Company held by him, and so in proportion for any less or the greater number; but every request for those shares must be in writing, signed by the party requiring the same, and countersigned by the liquidator of the Midland Company. The agreement went on to provide that in the event of any person not holding enough shares to entitle him to shares from the Anglo-American Brush Corporation, fractional certificates would be issued which could be dealt in on the market. There was a further provision that the sale was to take effect from that date, subject to the agreement being confirmed by the shareholders before the 24th inst. For the purpose of giving legal effect to this agreement, if approved, the Midland Company would have to go into voluntary liquidation.

The CHAIRMAN said: The solicitor having explained the legal effect of the agreement, the shareholders would probably want to know from the Directors what had induced them to adopt this plan. At the last meeting the shareholders were told that it was hoped the large amount of money which had been spent in advertising the Company very thoroughly would lead to some return hereafter, or, in fact, during the then ensuing year; but they had been unfortunate enough not to have realised those hopes. The fact of the matter was that the Company had only a very small capital and they were obliged to work in a small way. They had to try to get as many orders from people as they could to put up installations on

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their own premises. for the Company had not the means to put up central stations, which, besides requiring a good deal of money to be spent, involved waiting a long time for results. They had found that a great number of people would have taken the light from them if they could have supplied it in the same way that a gas company would supply gas; but these people had not been willing to pay for separate installations on their own account, a fact which was not surprising in the present state of trade throughout the country. They had done some work, but as he had already stated, they had not been able to meet the expenses of the year out of the receipts. The directors had then to consider what should be done. To have attempted to raise fresh capital under the present circumstances would have been out of the question, and it then resolved itself into a question of liquidation or sale to another company. He had put himself into communication with Lord Thurlow, the chairman of the Anglo-American Brush Corporation, and after very full consideration and discussion, the provisional agreement which the solicitor had described had been entered into, subject to the approval of the shareholders, by which one £5 share in the Anglo-American Brush Corporation would be given for every 6¾ shares of £2 10s. each in the Midland Company. They would get in cash a little more, and in fact, value considerably more than if they liquidated without entering into this agreement. The Anglo-American Corporation would pay all the expenses of liquidation, and they would take over the installations on hire. These installations were worth something as a going concern; but if the Company went into liquidation pure and simple they would be worth very little indeed. Under all the circumstances the agreement was so favourable that he did not think the shareholders would hesitate for a moment in accepting it. The Board had gone into the matter very fully, and they were of opinion that the arrangement should be adopted in the interests of all concerned. He moved:—"That the provisional agreement submitted to this meeting, and made between this Company of the one part, and the Anglo-American Brush Electric Light Corporation (Limited), of the other part, be and the same is hereby approved and sanctioned."

Mr. JAMES PENDER seconded the motion.

A SHAREHOLDER said he was opposed to the agreement, and he preferred voluntary liquidation. If they went into liquidation they would get something, for they had £5,000 in hand, whereas by amalgamation with the parent company they would get nothing but uncertainty, with the probability of losing all.

The CHAIRMAN said he believed the Company would get more by amalgamating than by going into liquidation.

The SHAREHOLDER added that the shareholders were asked to accept shares in the parent Company, while those shares were going down and were likely to drop still lower. He contended that it would be better to take 4s. or 5s. a share than to accept a nominal price of 7s. 6d. a share from the parent Company, and he thought this Company should have been paid for advertising the Brush system instead of having to pay for concessions.

Mr. MATTHEW remarked that after their experience of the Anglo-merican Brush Corporation, which had sold for £43,000 a patent which it did not possess, he did not think the shareholders of this Company would wish to put themselves into the hands of that corporation, which had shown itself to be absolutely unreliable and untrustworthy. They had £5,000, and this would give them 10 per cent. on their holdings. He proposed as an amendment that the Company should go into voluntary liquidation, and that the winding-up should be carried out under the supervision of five of the shareholders, to be appointed at that meeting.

Mr. BURRIDGE seconded the amendment.

The CHAIRMAN said the shares which the shareholders would receive in exchange for their present holdings would be worth cash; and

Mr. HARRINGTON pointed out that Anglo-American Brush shares were not falling in price, as had been said; they had risen ten shillings within the last month.

Mr. HEWETT, as one of the largest shareholders in the Company, expressed his belief that the Directors had done their best to promote the interests of the shareholders, and he contended that it was better to accept the shares offered, which were £10 shares reduced to £5, than to go into liquidation with the hope of getting four shillings or five shillings a share.

The CHAIRMAN said the Board had an overwhelming number of proxies in favour of the agreement.

Mr. BURRIDGE thought the shareholders present ought to have a voice in the matter. He was certainly opposed to the amalgamation.

Mr. CHINNERY asked what it was estimated would be returned to the shareholders if they decided upon going into voluntary liquidation?

The CHAIRMAN said that, exclusive of the costs of liquidation, and apart from what the installations on hire might fetch, they would get about 8s. 10d. per share; but actually the net amount which the shareholders would receive would be about 6s. per share. Of course, if they divided the cash, they would have to include the Anglo-American Brush Corporation, which held about a fourth of the capital of this Company.

A SHAREHOLDER asked whether the present installations were paying?

The CHAIRMAN replied that they were about paying their expenses.

The amendment was then put and negatived, and the Chairman's motion was adopted by 11 to 4.

In reply to Mr. HARRINGTON the Chairman stated that the proxies in favour of the agreement represented more than half the voting power of the Company.

The CHAIRMAN then moved "That with the view of carrying into effect the agreement between this Company and the Anglo-American Brush Electric Light Corporation (Limited) submitted to and approved at the extraordinary general meeting of the Company held this day, the Company be wound up voluntarily under the provisions of the Companies Acts."

Mr. JAMES PENDER seconded the motion, and it was adopted.

The meeting then closed.

The Oriental Telephone Company.

The following notice to the shareholders has been issued by the Directors of the Company:—

The Directors think it necessary again to urge each individual shareholder carefully to consider his position in this undertaking, and if possible to attend the meeting. If unable to do so, he should well weigh all the circumstances before giving his proxy to be used against the Board. Shareholders will have received a circular, signed by Mr. Thomas Lloyd, written in the interests of those who have called the meeting. The only point raised in that circular which has not been already anticipated by the Board in their circular of 29th ultimo refers to the relations of the fully paid-up shares to the part paid-up shares. In order that the proprietors may not be deceived on this point, they are reminded that the holders of fully paid-up shares cannot benefit, in any way, until the part paid shares have received cumulative dividends to the aggregate amount of 30 per cent. Hence it must obviously follow that the holders of fully paid-up shares are even more interested than are the holders of part paid shares that the capital called up on the latter shall be kept down to the lowest possible figure. The Directors cannot pass over the unworthy suggestion of an intention on their part of allowing the Company to drift into a liquidation, so as to benefit the holders of fully paid-up shares. It ought not to be necessary to say that there is nothing in the position to justify such a suggestion. Shareholders must, however, themselves judge, whether the present agitation is the best mode of avoiding the liquidation which Mr. Lloyd appears so much to fear. Not only have the Directors voluntarily placed at the disposal of the shareholders all the records of the Company, but they have frequently expressed their willingness to admit into their counsels one or two large shareholders who might care to join the Board; but this proposition has not been accepted. It is obviously impossible for the present Directors to remain on a Board which, if added to in the hostile manner proposed by the resolution, would of necessity force them into the position of mere dummies. For the rest, Mr. Lloyd's circular refers to the connection of certain members of the Board with another company. It is not too much to ask that members of this Company shall not allow themselves to be prejudiced by such allusions without first informing themselves fully upon both sides of the matters referred to.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. DEC. 10.		BUSINESS DONE WEEK ENDING DEC. 10. Highest.		Lowest.
Anglo-American	84,	85	84½		83½
Do. Preferred	59½,	59½	59		57½
Do. Deferred	9,	10	9⅛		9⅛
Brazilian Submarine	11½,	11⅝	11½		11½
Cuba	11,	11½	—		—
Do. Preference	17,	18	—		—
Direct Spanish	3½,	4	—		—
Do. Preference	14½,	15½	—		—
Direct United States Cable	10½,	10⅝	10½		9 15-16
Eastern Telegraph	11⅝,	12	11 15-16		11⅛
Do. 6 per Cent. Preference	13⅜,	13½	13½		13 11-16
Do. 5 per Cent. Debentures, 1899	104,	107	106½		106
Eastern Extension	12⅜,	12⅝	12 5-16		12⅜
German Union	9½,	10½	10½		10½
Globe Telegraph and Trust	7½,	7⅝	7⅝		7½
Do. Preference	12⅜,	12⅝	12⅝		12½
Great Northern	14½,	14⅝	14⅝		14⅜
Indo-European	32,	33	32⅝		32⅜
Reuter's	7,	7½	7½		—
Submarine	175,	180	178		175
West India and Panama	⅜,	1	13-16		—
Do. 1st Preference	7½,	7⅝	—		—
Western Brazilian	6½,	7½	7½		7
Western Union 7 per Cent. 1st Mortgage	120,	125	—		—
Do. 6 per Cent. Sterling Bonds	100,	103	—		—

TELEPHONES.

Consolid. Telephone and Maintenance	⅜,	½	7-16		—
Oriental	½,	⅝	—		—
United Telephone	11½,	12½	12 3-16		11⅛ x.

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	1⅝		1⅜
Do. (fully paid)	3½,	3⅝	3½		3⅜
Hammond Light (£3 15s. paid)	⅝,	¾	¾		⅝
Swan	—	—	—		—
Maxim-Weston	3-16,	5-16	—		—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35½		35
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	23½		22½

TRAFFIC RECEIPTS FOR NOVEMBER, 1884.

COMPANIES.	Nov., 1884.	Nov., 1883.	Increase.	Decrease.
Direct Spanish Telegraph	1,736	1,781	—	45
Eastern Extension	42,286	36,719	5,567	—
Eastern Telegraph	55,640	49,390	6,250	—
Great Northern	22,800	—	—	—
West Coast of America	4,015	—	—	—

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NOTES.

CHRISTMAS WEEK.—*The Electrician* will be published on Wednesday instead of Friday.

THE BENNETT-MACKAY CABLES.—It is reported that these cables are now in working order.

TELEGRAMS FOR BRITISH GUIANA.—The cable between Trinidad and Demerara is interrupted.

VIENNA ELECTRICAL EXHIBITION.—The official returns show that the receipts amounted to 350,800fl. (about £35,080), the number of visitors being 881,000.

ELECTRICAL EXHIBITION IN VIENNA.—A permanent exhibition of electrical apparatus is announced to open shortly in the middle of the city, where the various instruments shown may be experimented with.

PRESIDENT OF THE TELEGRAPH ENGINEERS.—Mr. C. E. Spagnoletti, of the Great Western Rallway, has been elected president of the Society of Telegraph-Engineers and Electricians for the ensuing year.

A DRAMATIC ELECTRICIAN.—Dr. Harry Lobb, the elec trician, has written a new idyllic and lyric one-act play, "Sappho," which will be played for the first time at a Lyceum *matinée* early in the new year.

BERLIN TELEGRAPH CONFERENCE.—This Conference is announced to open on 10th August, 1885. Official invitations will be sent to the Governments of all the countries which took part in the St. Petersburg Confederation.

STORAGE CELLS.—In our note last week on the above subject, the useful capacity of the Electrical Power Storage Company's cells exhibited was stated to be 100 ampere-hours, instead of 300, which, we are informed, is the useful output of the size in question.

THE TELEPHONE IN RIO JANEIRO.—After two years' hard competition, the two telephone companies—the Companhia Telephonica and the Companhia de Telegrafos Urbanos—the former with 300 and the latter with 750 subscribers—have agreed to an amalgamation.

PERSONAL.—The Globe Electrical and Engineering Company, under the management of Mr. Walter D'Alton, M.I.M.E., has taken over the manufacture of Mr. Killingworth Hedges' fusible safety catches or cut-outs, and has opened offices at 20, Dartmouth-street, Westminster.

WAX VERSUS ELECTRIC LIGHT.—The *Daily Telegraph's* Vienna correspondent telegraphs that the hardly credible report comes from Rome that the Pope has forbidden the use of electric light in Catholic churches. Do wax candles give a purer, healthier, cleaner light, or is gas preferred?

APPOINTMENT.—Messrs. Tasker, Sons, and Co., of Sheffield, have received from the Lord Chamberlain the appointment of telephone engineers to Her Majesty, in recognition of the satisfactory nature of the telephone work recently done by them at Balmoral, Abergeldie, Ballater, and Windsor.

ELECTRIC LIGHT AT ANTWERP.—The Brussels Compagnie Générale d'Electricité has been authorised by the Antwerp Municipality to light the eastern quarter of the city (that near the State Railway Station), including the Avenue de Keyser. The installation is expected to be complete by 12th February of next year.

ELECTRIC LIGHT FOR LECTURES.—On the occasion of the popular lectures given recently by Mr. Eric Bruce, at the Crystal Palace, Kensington Assembly Rooms, Grosvenor Hall, and other places, the stage was lit by means of the Electrical Power Storage Company's cells, which also furnished the current for the experiments.

ELECTRIC LIGHT FOR REGENT-STREET.—On Monday the lighting committee of St. James's, Westminster, consisting of Mr. E. C. Keevil, Mr. N. Jenkins, Mr. C. Lewis, and Mr. J. Bonthron, visited the dynamo works at Greenwich, and the electric lighting station at Paddington, with a view to examine the system and apply the same to Regent-street and Piccadilly.

ELECTRIC LIGHT AT COLLIERIES.—The pit heap at Burradon, Northumberland, is now illuminated by the electric light, arc lamps having been placed at various points. Shed on the screens in particular, a flood of light enabled the screeners to perform their labour with comparative ease. The power is obtained from a small engine, placed in the engine room connected with the pit.

CAB, FIRE, AND POLICE CALLS.—It is proposed to establish in London a system of "cab call and police and fire communications," by means of a dial placed in the hall of a subscriber's house, another at the nearest rank, a third at the fire brigade depot, and a fourth at the police station. Capt. Shaw has reported favourably of the scheme, and a company has been formed to work it.

THE TELEPHONE IN COLUMBO.—A telephone concession has been granted to José R. Martinez, who has handed it over to the Companhia Colombiana de Telefonos, of which he remains the general manager. The wires are overhead; and conversation may be carried on day and night, there being communication with the fire and police stations. The subscription is £1 per month or £12 per annum.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The directors of this company have declared an interim dividend of 3s. per share, or 6 per cent. per annum, free of income tax, for the quarter ending 30th September, and payable on the 24th December. The books of this company will be closed from the 17th to 23rd December, both days inclusive. The traffic receipts of the company for the week ended 12th inst. amounted to £3,880.

ELECTRIC LIGHT AT BELFAST.—On Tuesday at a meeting of the Belfast Harbour Commissioners, Mr. John Greenhill moved that they should ask three or four of the leading electric light companies to give an estimate as to the illumination of the sheds and quays by the electric light for three or five years, the company to supply all appliances. Mr. W. C. Mitchell seconded the resolution; but it was lost, the mover and seconder only voting in its favour.

THE CREIL EXPERIMENTS.—The *Bulletin* of the Compagnie Internationale des Téléphones states that, thanks to the experience acquired in mounting the first generator, the second is, according to the Creil engineers, put down under much better conditions of working, as regards the suppression of passive resistance. In addition to the transmission of power, M. Marcel Deprez intends, in conjunction with Dr. Hertz, to conduct, at Creil, experiments in long-distance telephony.

ELECTRIC LIGHT IN PARIS.—Burrington, jeweller, in the Rue Castiglione, Paris, has placed a small incandescent lamp in each of his four glass cases, which were too small to admit a gas flame. The lamps are fed by four 6-element bichromate of potash batteries, the exciting liquid of which has to be changed every morning. Prat and Victor, Rue de Moscou, have placed two incandescent lamps in their office, and four outside the house, maintained by Trouvé bichromate batteries.

THE TELEPHONE IN MONTEVIDEO.—The Compania Telefonica, La Uruguaya, now under the control of Messrs. J. K.

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Theobald and Co., of Buenos Ayres and Montevideo, which has in use over 700 Bell telephones in Montevideo, has given an order for 300 more to the United Telephone Company, River Plate. The United Company supplied at once 100 from a shipment arriving on 5th inst. by the "Malabar," and cabled for the remainder. La Uruguaya company expects to have 1,000 subscribers in Montevideo.

DOMESTIC ELECTRICAL POWER.—The generating machines of the Compagnie Electrique may be used both for light and power. M. Daguin has put one down, at a leading Paris restaurant, for driving knife-cleaners, bottle-washers and floor-polishers during the day, and causing the carbon filaments of the lamps to glow in the evening.—A company, called "Le Chrôme," has been formed in Paris for supplying and maintaining, by contract, special chromic acid batteries, for lighting and various domestic applications.

BON MARCHE INSTALLATION.—This title must not be read literally, because it would convey just the wrong signification. We refer to the electric light installation at the large drapery establishment known as the Bon Marché, in Paris. As long as the current was supplied by dynamos, all went well; but the directors refused to allow them on the premises, so bichromate of potash batteries were tried instead. These made too great demands upon the purse; and now—can one believe it?—gas is re-instated at the Bon Marché.

GAULARD AND GIBBS.—It appears from a letter by Signor Ferrini to the *Lumière Electrique* that the 90 per cent. of work recorded at Turin, was obtained by measuring the intensity of the primary and secondary currents with two Siemens electro-dynamometers, previously compared with one another, and the differences of potential at the respective terminals with two Mascart electrometers. It is, therefore, not the useful effect, that is to say, the ratio of energy expended to energy recovered, but simply a co-efficient of transformation proper to the apparatus.

TELEPHONE SUBSCRIPTIONS.—According to *L'Electricité*, the following are the rates of subscription to the telephone exchanges in the following European cities and countries:—London, £20; Paris, £24; Riga and Odessa, £25; Austria, £9 to £15; Germany, from £10, with an increase of £2 2s. for every kilometre (1·24 mile) over two; Italy, varying from £4 12s. to £7, with the towns; Norway, £4 to £8, according to distance; Sweden, £6 8s. to £10 16s; Holland, £10; Portugal, £15 for traders and £7 for private individuals; Switzerland, £4 to £10.

THE TELEPHONE IN VIENNA.—By the end of June last the Vienna telephone lines attained a length of 175 kilometres (108 miles). The total length of wire in the cables was 1,300 kilometres (807 miles), and in underground lines, of silicon bronze wire 1mm. in diameter, 1,683 kilometres (1,045 miles.) The number of subscribers was 708, and that of direct connections 120. In the month of June nearly 52,500 messages were sent by the subscribers, making 1,750 a day. The two central offices, which open at 7 o'clock in summer and 8 o'clock in winter, closing at 9 o'clock, are served by 42 girls.

THE TELEPHONE IN PARIS—It is rumoured that the Société des Téléphones is trying to obtain from the Paris Municipal College a reduction from the rent charged on telephone lines, and also a continuation of the permission to fix wires in the sewers instead of overhead, while holding out the hope of giving increased facilities to the public in the shape of "call" offices. The French Minister of Posts and Telegraphs, while recently prolonging for five years the present concession of the company, stated that he would not refuse a similar concession to a competing company offering adequate guarantees.

COMMUNICATION BETWEEN ENGLAND AND BRITISH NORTH BORNEO.—Speaking at the half-yearly meeting, on Wednesday, of the shareholders in the British North Borneo Company, Sir Rutherford Alcock, alluding to the progress of the colony, said that he did not even despair of their territory being put in telegraphic communication with England before any long time elapsed. There was, indeed, some chance of it now, as the question was under consideration of a duplicate line from Manilla and Hong Kong. It would be a great gain to them to have telegraphic communication with this country.

UNDERGROUND WIRES IN PHILADELPHIA.—The Western Union Company has made an arrangement for running wires underground with Mr. David Brooks, who says:—"The company agrees to use 100 wires in the cable, which I will lay down for a term of seven years with the privilege of renewing at the end of that time. The trunk line of the cable will be on Broad-street; and the cables will run from the Broad-street Station to Third and Chestnut-streets, where the Western Union people expect to establish their main office. Another cable will be run to Tenth and Chestnut-streets, and one from there to the Kensington Station."

NEW ORLEANS EXHIBITION.—The opening of this Exhibition, covering 60 acres, took place on Tuesday last, amid great enthusiasm. Telegraphic communication was established between the building and the White House at Washington, where President Arthur had assembled the members of the Cabinet, the presiding officers of both Houses of Congress, the members of the Diplomatic Corps, and the judges of the Supreme Court. A telegraph instrument brought intelligence into the room that all was ready, when the President formally declared the Exposition opened; and the message was received at New Orleans a moment later. The engine for driving the machinery then started, and the pullies began to revolve. It is expected that the Exhibition will be completed in a week's time, and that it will be equal in importance to that of Philadelphia.

INTERNATIONAL INVENTIONS EXHIBITION.—With a view to giving further protection to the inventions of exhibitors, a new certificate has been granted by the Board of Trade to the effect that "the International Inventions Exhibition proposed to be held at South Kensington, in the county of Middlesex, from the 1st day of March, 1885, is an International Exhibition;" and by this means all the protection, accorded from the 1st of May to inventions under the original certificate (dated the 15th of August), will be secured in addition from the 1st of March till the 1st of May—namely, during the time in which the exhibits will be received and arranged. A printed copy of the extracts from the "Patents, Designs, and Trade Marks Act, 1883," bearing on this subject, may be obtained on application to the Secretary, International Inventions Exhibition, South Kensington, S.W.

SIXPENNY TELEGRAMS.—In view of the greater influx of messages which may be anticipated in consequence of the adoption of the cheaper rate of telegraphing in August next, the Electrical Department of the Post Office is adding a large number of new wires throughout the metropolis and the provinces. In London, notably in the Paddington district, along the Uxbridge-road and other main thoroughfares, the wires have been placed in iron piping underground, it being the intention of the authorities to do away as far as practicable with all overhead wires; and the pneumatic tubing now so

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successfully worked between the London Central Telegraph Office and the City offices will, it is anticipated, be extended to the various district offices throughout the metropolis, thus enabling the department to turn the wires in present use at these offices, about twelve in all, to another account.

ELECTRICAL VERIFICATION OF DEATH.—This subject has been revived by Dr. Buch, who finds that, in the living subject, the temperature rises appreciably at the surface of the muscle subjected to the action of an electric current, and also that this increase of temperature never occurs in a corpse, under similar circumstances, even during a few hours after death. He uses an ordinary mercurial thermometer, which is simply applied to the surface of the skin, waits until the height of the mercury remains constant, and then submits the subjacent muscle to an induced current, when the temperature of the skin increases several degrees under the influence of energetic contraction. This phenomenon is constant in living persons, even in the case of total paralysis; but, in the case of a corpse, the mercury remains stationary, notwithstanding the force of the current and the violence of the contraction.

TRADE AND THE TELEGRAPH.—In the course of remarks in his address, on the evening of the 17th inst., before the Institute of Bankers "On the Prices of Some Commodities during the Decade 1874-83," Mr. Luke Hansard stated that the more extended use of the telegraph had had the tendency of making over-supply more prominent. In the various channels of distribution less stock was required than formerly, from the retailer upwards, owing to the rapid manner in which supplies can be ordered. The large manufacturer was not now under the same necessity of keeping stock by him as formerly. "The telegraph," continued Mr. Hansard, "has enabled the merchant or wholesale dealer to make more frequent use of the markets abroad, and from the rapid increase both in the speed and number of steamers he can have his orders executed in an incredibly short space of time, compared with 10 years ago. From the less time the stock is on hand there is less uncertainty in any venture, and traders can carry on business with smaller capital than formerly, with the effect of squeezing out the middleman and further lessening the cost of distribution."

INCANDESCENT INSTALLATION NEAR PARIS.—We learn from *L'Electricité* that an interesting application of the incandescent light has been made to the colour works of MM. Sordes et Huillard, at Suresnes, near Paris, to the extinction of about 800 gas flames. Current for the hundred and thirty-odd lamps is supplied by an Edison dynamo, which, at a speed of 1,050 revolutions a minute, gives out 110 volts at 90 amperes, while absorbing 16 horse-power from one of the works' engines, the steam for which is obtained from a large boiler used to heat the pans. The dynamo and switch-board are placed in a building where the workmen are forbidden to enter; and the extreme points of the circuit are about 150 yards apart. Those lamps which light the pans that are filled with steam are inserted in paraffined sockets, which stand the damp atmosphere. The two residences of the partners, which are near the works, are connected therewith by a special circuit, and provided with incandescent lamps on all the floors. As the dynamo is kept running day and night, light may be obtained at any time. The yearly expenses are stated to be 7,930f. (£317), including interest on capital and sinking fund, while gas for the previous year cost 11,800f. (£432).

KEEPING MILK BY ELECTRICITY.—Our readers will remember the conversation, attributed to Edison by a recent interviewer and reproduced in these columns, as to the effect of electric current in "aging" whisky. Another and more generally useful application of the subtle influence, that of keeping milk sweet, has been communicated by a correspondent to the *Standard* as follows:—"In reference to the London milk supply from Holland and the keeping of milk sweet, by icing or other means, I may mention that I repeatedly saw the late Mr. Andrew Crosse, in his laboratory at Fyne Court, make experiments in subjecting milk to electric action, whereby it was kept sweet for weeks together. In the 'Memorials of Andrew Crosse,' p. 219, the very simple arrangement is described:—'Two cylinders of sheet zinc and sheet iron are severally placed in two porous earthenware tubes, open at the top, closed at the bottom, the same being filled with water . . . . and connected at the top by a copper riband. . . . The earthenware vessels are placed in the fluid (milk or other), the electrical action immediately commences, and the fluid becomes antiseptic in a few hours,' p. 221. 'Milk has been kept sweet for three weeks by this process in the middle of summer.'"

GREAT WESTERN ELECTRIC LIGHT COMPANY.—Notice is given that an extraordinary general meeting of this company will be held at the offices, 4, Great Winchester-street, on Tuesday, the 23rd inst. at noon, for the purpose of considering and, if deemed advisable, of confirming as special resolutions the following resolutions, which were passed at the extraordinary general meeting held on the 8th inst., viz.:—1. That the conditional agreement submitted to this meeting, and made between this Company of the one part, and the Anglo-American Brush Electric Light Corporation, of the other part, be, and the same is hereby approved and sanctioned. 2. That with a view to carrying the said conditional agreement into effect, the Company be wound up voluntarily, and that Mr. Emile Garcke and Mr. F. W. Reynolds be, and they are hereby appointed liquidators for the purpose of such winding up. 3. That pursuant to the Companies Act, 1862, the said liquidators be, and they are hereby authorised and directed to adopt, on behalf of this Company, the said agreement, and to receive paid-up shares in the said Corporation, as consideration for the property thereby agreed to be sold in accordance with the terms of such agreement, and generally to carry the same into effect.

AN ELECTRICALLY-WORKED CRANE.—We learn from the *Bulletin* of the Cie Internationale des Téléphones that, during last month, a 20-ton crane, the motions of which are given by the electric current, has worked in the foundry of M. Farcot, at Saint-Ouen. The generating machine, placed rather over 100 yards from the crane, gives a current at the terminals of about 350 volts at 13 amperes when making 1,550 revolutions a minute. The receiving apparatus, attached to the crane, makes 1,000 revolutions a minute, and exerts a power of four horses at its shaft. A special rheostat permits of progressively introducing resistances which may amount to 60 ohms, and, consequently, of varying at will the speed of lift. No change has been made in the parts of the crane, which may be worked by hand when the steam-engine is not running. A Mégy brake, made by Sautter et Lemonnier, would prevent the load from falling in the event of any accidental derangement. In lifting heavy castings from their moulds, a vacuum is caused, owing to which the total or partial atmospheric pressure is added to their weight, which might thus exceed the power of the crane. In such a case, the circuit is interrupted automatically, thus warning the engine-man. By the aid of the electric current one man now works the crane instead of ten as formerly.

NATIONAL TELEPHONE COMPANY.—This company has issued a new list of subscribers in the Glasgow district for the month

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of December. The first telephone was installed at Glasgow in October, 1879; and there are now in operation over 900 exchange and 300 private lines. The subscribers now number about a thousand; and additions are being made daily. A good thing for Glasgow is that there is now only one exchange system, all the other telephone interests having been amalgamated in the National Telephone Company. The company offers its subscribers either private wires for exclusive communication between two or more fixed points, or wires connected with the nearest exchange—the latter affording direct communication with every subscriber to the exchange system. The objection of principals to being called and asked questions which can be answered by their clerks, or having to talk in the hearing of others, is met by arranging one set of instruments in the clerks' and another in the principal's office. The company is also prepared to lay down temporary lines for special purposes, for instance between the offices of engineers, architects or contractors and the works they are superintending or carrying out. The exchanges are open day and night; and ten call boxes are established for the use of subscribers, while a corps of commissionaires has been organised in connection. Besides the Fire Brigade Depot, the St. Andrew's Ambulance Association and the Royal and Western Infirmaries are put in communication.

NEWCASTLE-ON-TYNE.—The Trustees of the Fund resulting from the North-East Coast Exhibition of Naval Architecture and Engineering, held at Tynemouth in 1882, have applied the surplus proceeds of the Exhibition to the foundation of a scholarship, of the annual value of £30, tenable for two years, at the Durham College of Science, Newcastle-upon-Tyne, to be called the North-East Coast Naval Architecture and Engineering Exhibition. The College, in accepting the offer of the Trustees, has agreed to remit the whole of the fees in the case of the holder of the exhibition, so that the actual value of the scholarship will be about £60 per annum. Candidates must be apprentices or workmen engaged in one of the shipbuilding or engineering establishments in the district of the Tyne, Wear, or Tees. The exhibition will be awarded on the result of a competitive examination in elementary mathematics, pure and applied mechanics, physics, and inorganic chemistry; and the exhibitioner will, in the first instance, be elected for one year, but will continue to hold the exhibition for a second year if his progress be satisfactory. The first examination will commence on Thursday, 15th January, 1885, and candidates must send their names to the Secretary of the Durham College of Science on or before Saturday, January 10th. It is expected that before long a chair of naval architecture and marine engineering will be founded at the Durham College of Science; and in the new buildings of the college special provision will be made for experimental work in connection with this chair.

BRITISH ASSOCIATION.—At the close of the British Association Meeting at Montreal, the suggestion was brought forward that, in commemoration of the meeting, and as a recognition of the hospitality with which the members of the Association had been treated in Canada, it would be a graceful act to form a fund for the purpose af founding a gold medal at the McGill University at Montreal. After consultation with the authorities of the university, it was agreed that, subject to further consideration, the medal should be given annually, in the Faculty of Applied Science, in which there is at present no prize of this sort. Lord Rayleigh, the president of the association, undertook to act as treasurer, and Mr. W. Topley and Mr. H. Trueman Wood as honorary secretaries. In answer to an appeal circulated amongst the members in Canada, and to a circular which has been issued in this country since the return of the association, a sum amounting at present to £540 has been subscribed. Deducting the necessary expenses of printing and postage, there will remain an amount of something over £500 to provide the medal. The general committee of the association have agreed to provide from its funds sufficient for the purchase of a die, so that the interest resulting annually from the investment of the whole of the above amount may be available for the medal itself. The honorary secretaries will be glad to receive contributions from any members of the association who may not yet have subscribed. These may be sent to them at the Society of Arts' house, John-street, Adelphi; or may be paid into the account of the fund, at Messrs. Hoare's, 37, Fleet-street.

"THE MONTHLY CORRESPONDENT."—This is the title of a little monthly magazine, dedicated to the staff of the Brazilian Submarine Telegraph Company, and issued at Madeira. It was started a year ago by Mr. E. B. Barker, clerk-in-charge, with the object of affording information on subjects of general or particular interest to the company's staffs at the various stations; and an appeal was made to members of the profession to contribute articles connected with the theoretical and practical aspect of telegraphy. Considering the great difficulties in the way of such an undertaking, the *Monthly Correspondent* has made a very respectable show during the twelve months of its existence; and, as this is the season of good wishes, we hope it may live long and prosper with a progressively increasing circulation. It is difficult to estimate the value of such a publication in a little centre of Englishmen away from home. It creates interest in the daily work, and promotes *esprit de corps*, besides giving technical information that is more likely to be read and digested in such a form than in a large treatise. Telegraph clerks are, as a rule, too apt to be content with mere routine, without lifting their nose from the instrument. But if they would only magnify their office, and inquire into the why and wherefore of what they do, they would be fitting themselves for seizing hold of that chance which comes to every man at least once in his life. For instance, the clerk who, besides being a rapid and correct operator, has made himself acquainted with the engineering and electrical details of the instruments, might, on a hitch occurring, find himself able to set it right, and so save the delay and expense of sending an electrician out from England. Such a man would decidedly wear a feather in his cap, and be marked for promotion on a vacancy occurring.

DOMESTIC LIGHTING.—On Monday evening Mr. Robert Hammond, managing director, Hammond Electric Light and Power Supply Company (Limited), received a succession of visitors to inspect the arrangements for lighting his residence at Highgate. The installation has been down nearly three years, and is considered to be gradually paying off its first cost by the saving effected in renewals of paint, wall-paper, and decoration generally. The engine room is erected in the garden, and provided with an 8 horse-power Otto gas engine, in which an explosion takes place every other stroke. This engine makes rather over 150 revolutions a minute, and drives a Ferranti alternating-current dynamo at about 1,000 a minute, excited by a small direct-current Siemens machine. A resistance frame with German silver wires is interposed in the circuit, because the power and generating capacity are in excess of present requirements; so that Mr. Hammond is in a position to lend a little current to a neighbour on the occasion of a ball or *soirée*, or, indeed, to permanently light a neighbour's premises, without the exercise of any self-abnega-

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tion in this respect. We heard that there were in all 71 Swan lamps of 20 candle-power nominal, disposed about the premises, and were permitted access to the *penetralia* in order to count them. This number includes four in the engine room, one in the wine cellar, another in the scullery, two in the kitchen, with one naked movable lamp for inspecting the culinary operations, and others in bed rooms, dressing rooms, lavatory, and w.c.'s; in fact, there is no gas whatever about the premises. In the drawing rooms, nine lamps with appropriate shades are placed in the middle of movable shields hung round the walls, while three lamps are pendent from the ceiling and another is placed on a movable reading standard. In the dining room, what is called on the Continent a "suspension," or porcelaine dome suspended from the ceiling, has three naked lamps inside, while eight with shades are disposed round the circumference. These may be regulated, by means of a resistance coil, so as to give any desired amount of intensity. Mr. Hammond has a switch at the side of his bed, by which he can break contact, and allow a weighted sluice-valve to fall, thus shutting off the gas from the engine, and putting out the lamps. No electrician or engine driver is employed; but the gardener starts the gas engine and then leaves the plant to take care of itself. In our note last week of the *conversazione* at the Hammond Electrical College, we mistook for Mr. Phillips, the electrical engineer, who was unavoidably absent, Mr. F. R. Barrett, B.A., B.Sc., the mathematical lecturer, who showed some of the electrical apparatus.

COMMUNICATION BETWEEN THE SHORE AND LIGHT SHIPS.—It often happens that a vessel is lost after battling with the sea for several hours in sight of a light ship, and might have been saved if a message could have been sent on shore. But the difficulties in the way of affording such communication have hitherto been regarded as practically insurmountable. They originate mainly in the constant and excessive motion of the light ships, which are moored at the bow by a chain cable 4½in. in circumference, "payed" out sufficiently in rough weather to allow them to ride and swing freely. In this way they often describe a complete circle; and, to prevent the telegraphic cable from being fouled by the moorings, if separate from the latter, especially as it would have to be similarly "payed" out to keep it from parting, has been the main problem. Another danger to be guarded against was that of damage to the telegraphic cable by ships' anchors, light-vessels being generally moored in shallow waters. A year or two ago, however, the whole matter was placed in the hands of the Telegraph Construction and Maintenance Company (Limited); and a contract was entered into whereby, as a practical experiment, they were to electrically connect the "Sunk" light-vessel with Walton-on-the-Naze, and maintain such communication for one year, no payment being made in the event of any failure to comply with the conditions, unless such failure should arise during the working of the cable from exceptional causes for which the contractors could not fairly be held responsible. The first part of this contract has now been fulfilled, considerable delay having previously occurred, owing to the necessity for several series of experiments at the company's works and elsewhere. It was foreseen at the outset that, to guard against the dangers already indicated, the telegraphic cable must be enclosed within the ship's moorings; and to determine the best form of the latter the experiments in question were undertaken. Ultimately it was resolved to adopt a hollow steel wire rope, 8½ inches in circumference, formed by fourteen twisted strands; and this rope—capable of bearing a tensile strain of 70 tons, and having the telegraphic cable running through its centre—constitutes the present ship's mooring, in lieu of the chain of 4½ inch circumference previously employed. On the 3rd inst. the contractors commenced the operation of laying the cable and moorings. Owing, however, to strong south-westerly winds, little could be done for several days beyond fixing the telegraph instruments, consisting of a Morse transmitter, a Wheatstone A.B.C., and a telephone on board the light vessel, and also at Walton-on-the-Naze, and laying the shore end of the cable at the latter place; but on the 7th and 8th inst. the entire work was accomplished with a success which promises well for its future working. This light ship, moored in ten fathoms at low water, is about nine miles from Walton-on-the-Naze. The cable passes under the public road to the post office at that place, which office is in direct communication *vid* Colchester with Harwich, from whence the various lifeboat stations along the coast are easily accessible by telegraph.

ELECTRIC LIGHTING ACT.—The following is a list of the members of the General Committee, formed on the suggestion of the President of the Board of Trade, to frame clauses in amendment of the Electric Lighting Act, 1882, and to confer with the Board of Trade as to the terms of the provisional orders and licenses:—

The Right Hon. Lord Thurlow, Chairman of the Anglo-American Brush Electric Light Corporation.
The Viscount Anson.
Sir F. Abel, K.C.B., F.R.S.
Sir F. J. Bramwell, F.R.S.
Sir Charles Bright, M.I.C.E., Vice-President of the Society of Telegraph Engineers and Electricians.
Sir Daniel Cooper, Bart., K.C.M.G., Chairman of the Electrical Power Storage Company.
Sir Rawson W. Rawson, K.C.M.G., C.B., Chairman of the Pilsen-Joel and General Electric Light Company.
Sir David Salomons, Bart.
Sir Wm. Thomson, F.R.S., LL.D.
Sir C. L. Young, Bart., Chairman of the Hammond Electric Light and Power Supply Company.
Professor W. E. Ayrton, F.R.S.
J. B. Braithwaite, jun., Esq., Managing Director Great Western Electric Light and Power Company.
R. Campbell, Esq.
Latimer Clark, Esq., M.I.C.E.
Henry Cunynghame, Esq., Author of "The Law of Electric Lighting."
J. Irving Courtenay, Esq.
R. E. Crompton, Esq., of Messrs. R. E. Crompton and Co.
Professor W. Crookes, F.R.S.
Professor Ewing.
Professor G. Forbes, M.A., F.R.S.E.
James Staats Forbes, Esq., Chairman Edison and Swan United Electric Light Company.
Captain Douglas Galton, C.B., F.R.S.
Herbert C. Gibbs, Esq.
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THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 49.

Dissimilar Coils. Characteristic Function of a Linear System of Conductors.

As might be expected, when, in the combination as specified in the last section, the coils and cores are made dissimilar in their dimensions and materials, it is no longer possible to express the general solution in terms of two comparatively simple solutions, although with special relations amongst the coil data it may sometimes be expressed in terms of a limited number of simpler solutions. Now, so far as the mere algebra goes we can easily arrive at the general solution when the coils are dissimilar, and in fact more easily than when there are particular relations introducing indeterminateness in the general solution, requiring special attention; but, owing to difficulties of interpretation, the general solution has very limited utility, except in showing how we might, if we gave the time to it, completely solve the problem numerically. But there are, on the journey to the general solution, some views by the way which make it more interesting and instructive than it would otherwise be, and it is to exhibit them, rather than a mere mathematical complication, that the present section is written, before leaving coils in combination and proceeding to other parts of the subject of induction in cores and elsewhere.

Starting, in the first place, with a linear system of conductors, self-contained, that is, having no connection with other conductors, let there be q points connected by $\frac{1}{2}q\,(q+1)$ conductors, the least number that will join every point with all the rest. Let their potentials be $P_1, P_2, \ldots$. To distinguish the different conductors, use double suffixes. Thus, let K_{12} be the conductivity (reciprocal of resistance) of the conductor joining the points 1 and 2, and Γ_{12} the current from 1 to 2, with a similar notation for the rest.

Continuity of current requires that the sum of the currents leaving any point shall vanish. Thus, for point 1, we have

$$\Gamma_{12}+\Gamma_{13}+\Gamma_{14}+\ldots+\Gamma_{1q}=0, \quad . \quad . \quad . \quad (124)$$

There are $q-1$ other equations of this kind, got by changing the first suffixes.

Next, let E_{12} be the impressed force from 1 to 2, and similarly for the other conductors; then, by Ohm's law,

$$\Gamma_{12}=K_{12}(E_{12}+P_1-P_2) \quad . \quad . \quad . \quad . \quad (125)$$

expresses the current in the branch joining the points 1 and 2 in terms of the impressed force in that branch and the potentials at its ends. There are $\frac{1}{2}q\,(q+1)$ equations of this kind. Insert in (124), and we have

$$(K_{12}E_{12}+K_{13}E_{13}+\ldots+K_{1q}E_{1q})+(K_{12}+\ldots+K_{1q})P_1 = (K_{12}P_2+K_{13}P_3+\ldots+K_{1q}P_q) \quad . \quad . \quad . \quad . \quad . \quad (126),$$

with $q-1$ other equations of the same kind. Here the quantity in the first ( ) is the current that would leave the point 1 by all the conductors meeting there if the impressed forces were the only forces; call it C_1, and similarly for the other points. Also, put

$$-K_{11}=K_{12}+K_{13}+\ldots+K_{1q} \quad . \quad . \quad . \quad (127)$$

and we get

$$\left.\begin{aligned} C_1&=K_{11}P_1+K_{12}P_2+K_{13}P_3+\ldots+K_{1q}P_q\\ C_2&=K_{21}P_1+K_{22}P_2+K_{23}P_3+\ldots+K_{2q}P_q\\ &\ldots\ldots\ldots\ldots\ldots\ldots\\ C_q&=K_{q1}P_1+K_{q2}P_2+\ldots\qquad\qquad+K_{qq}P_q \end{aligned}\right\} \quad . \quad (128)$$

Here, as we have q linear equations and q potentials, it looks as if we could find them. Thus, if K is the determinant of the K's, and Z_{rs} the coefficient of K_{rs} in this determinant, so that

$$K=K_{11}Z_{11}+K_{12}Z_{12}+\ldots+K_{1q}Z_{1q} \quad . \quad . \quad (129)$$

and similar expressions, we should have

$$KP_1=C_1Z_{11}+C_2Z_{21}+\ldots+C_qZ_{q1} \quad . \quad . \quad (130)$$

and similar expressions for the other potentials. But K_{11}, $K_{22}, \ldots$, are not independent of the other real K's, being defined by (127). This structure of the diagonal K's makes all the Z's identical, and the sum of the K's in any one row or column of (128) to vanish, so that if Z is the common value of the Z's, (129) becomes

$$K=(K_{11}+K_{12}+\ldots+K_{1q})Z=0\times Z,$$

by (127), and (130) becomes

$$0\times P_1=(\Sigma C)Z=0\times Z,$$

since the sum of the C's also vanishes. We cannot find the q potentials, but only $q-1$ of them, supposing the remaining one to be given.

Maxwell's investigation, Vol. I., Art. 280, differs from the above in the system not being self-contained, having external connections at the q points, at which there are given currents $Q_1, Q_2, \ldots$, entering the system. This only requires us to write C_1-Q_1 instead of C_1, C_2-Q_2 for C_2, &c. in (128). But regarding the fact that only $q-1$ equations are independent, Maxwell ascribes it to the necessary condition $\Sigma Q=0$. This reason is surely erroneous, for in the above there are no Q's to consider, and the reason fails.

We may therefore reject one of equations (128), say the last, leaving p equations, $(p=q-1)$; thus

$$\left.\begin{aligned} C_1-K_{1q}P_q&=K_{11}P_1+K_{12}P_2+\ldots+K_{1p}P_p\\ C_2-K_{2q}P_q&=K_{21}P_1+K_{22}P_2+\ldots+K_{2p}P_p\\ &\ldots\ldots\ldots\ldots\ldots\ldots\\ C_p-K_{pq}P_q&=K_{p1}P_1+K_{p2}P_2+\ldots+K_{pp}P_p \end{aligned}\right\} \quad . \quad . \quad (131),$$

which give the p potentials in terms of the C's and the rejected P, viz., P_q. This last we may put $=0$; as, if it is not to vanish, the effect is merely to add a common potential all round.

The determinant of K's in this last system of equations is the same as the before mentioned Z, except as regards sign, being negative when p is even and positive when p is odd. Its full expression may be written down mechanically. It may be called the characteristic function of the linear system. It contains in itself the expressions for the resistance external to every branch in the system, which expression can be got by inspection. Let there be only one impressed force E_{12}, and find Γ_{12} the current in the same conductor. If G_{rs} is the coefficient of K_{rs} in Z, we find

$$\Gamma_{12}=K_{12}E_{12}\left\{1+\frac{K_{12}}{Z}(G_{11}+G_{22}-2G_{12})\right\} \quad . \quad (132).$$

Now, Z containing only first powers of the K's, we may write, by picking out the terms containing K_{12}, in the full expression for Z from which the diagonal K's have been eliminated,

$$Z=K_{12}X+Y \quad . \quad . \quad . \quad . \quad . \quad . \quad (133),$$

where X and Y do not contain K_{12}. Further, we may show that

$$-X=G_{11}+G_{22}-2G_{12};$$

which, by (132) gives

$$\Gamma_{12}=K_{12}E_{12}(1-K_{12}X/Z)=K_{12}E_{12}Y/Z, \text{ by (133)},$$
$$=E_{12}(K_{12}^{-1}+X/Y)^{-1}, \text{ by rearrangement}, \quad . \quad (134).$$

Consequently, the resistance external to K_{12} is X/Y. Similarly, by isolating any particular conductivity in the expression for Z, as in (133), we obtain the resistance external to the conductor isolated.

Thus, let there be 4 points joined by 6 conductors (the well known "bridge.") The characteristic function is, if $s_1=a+b+c+d$,

$$Z=(a+b)(c+d)e+(a+c)(b+d)f+s_1ef+ab(c+d)+cd(a+b). \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (135).$$

The letters here stand for the conductivities of the branches as shown in the diagram, it being supposed that the four other branches g, h, i, j, are non-existent.

As arranged in (135), it is suitable for showing the resistance external to either e or f, those symbols being isolated.

Next, 5 points joined by 10 conductors. In the figure there is an additional junction 5, and four new conductors g, h, i, j connecting it with the former four points. The characteristic function is now the determinant of the K's from K_{11} to K_{44}, and is, the conductivities being expressed by the letters in the

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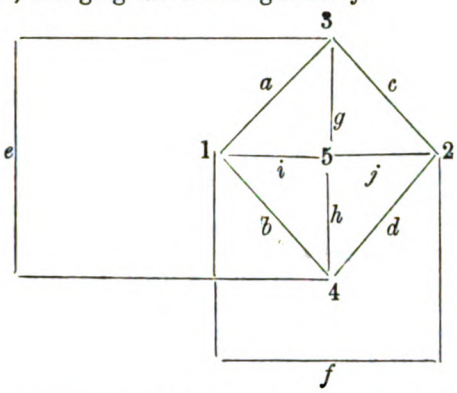
diagram expressed thus, using the additional symbol $s_2 = g + h + i + j$,

$$Z = e\{s_2(a+b)(c+d) + s_1 ij + (g+h)[i(c+d) + j(a+b) + ij]\}$$
$$+ f\{s_2(a+c)(b+d) + s_1 gh + (i+j)[g(b+d) + h(a+c) + gh]\}$$
$$+ ef\{s_1 s_2 + (g+h)(i+j)\} + ij\{(a+c)(b+d) + g(b+d) + h(a+c)\}$$
$$+ s_2\{ab(c+d) + cd(a+b)\} + gh\{(a+b)(c+d) + i(c+d) + j(a+b)\}$$
$$+ gi(bc + bd + cd) + gj(ab + ad + bd) + hj(ab + ac + bc)$$
$$+ hi(ac + ad + cd) + ghij \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (136)$$

As before, it is arranged suitably for giving the resistance external to either e or f; the complete coefficient of e, divided by the remaining terms, being the resistance external to e. Similarly for f. To get the resistance external to another conductor, say a, this symbol must be isolated. Or, more easily, rearrange the diagram, changing the lettering suitably.



The characteristic function also gives us the differential equation of the system when the self-induction in some or all the branches is taken into account. Thus, if R_{12} is the resistance from 1 to 2, and L_{12} the coefficient of self-induction, write $R_{12} + L_{12}D$ instead of R_{12} (or $1/K_{12}$) in the characteristic function, and similarly for the others; this being done,

$$Z = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (137)$$

is the differential equation of the system, if D stands for $\frac{d}{dt}$, D^2 for $\frac{d^2}{dt^2}$, &c. And D being algebraic, (137) is the determinantal equation, whose roots give the admissible time constants of subsidence, these being the negative reciprocals of the roots D_1, D_2, &c.

Equation (137) is also the determinantal equation when there are coils with cores in the different branches, but with a different meaning attached to the coefficients K. Let there be a coil with a core in every branch. To distinguish them, it suffices to number the principal symbols before used for a single coil. These are, Γ the coil current, R the resistance of the branch containing the coil, having N windings per unit length l; L the complete coefficient of self-induction of the branch, and M that part of it due to the core; H the magnetic force in the core of length l, and radius c, at distance r from the axis; ρ and μ the specific resistance and permeability of the core; $S = M\rho/2\pi\mu c$. Then

$$P_1 - P_2 = R_{12}\Gamma_{12} + (L_{12} - M_{12})\dot{\Gamma}_{12} + S_{12}\Gamma'_{12} \; . \quad (138)$$

as in (115), is the equation of E.M.F., which takes the place of (125), whilst (124) remains unaltered.

(TO BE CONTINUED.)

VICTORIA INSTALLATION.

The various platforms, waiting rooms, and public and private offices belonging to the London, Chatham, and Dover Railway at Victoria Station require at present about 750 amperes of current at a potential of 116 volts at the bars of the collecting switch-board in the dynamo room. This current is generated by a pair of dynamos manufactured for the purpose by Messrs. Crompton and Co. It was originally intended that these dynamos should be of the Crompton-Bürgin pattern, but after the armatures, as originally designed, were actually made and tried in position, it was found that the Bürgin form of armature was unsuited for such heavy outputs of current, and armatures of the new form designed by Mr. Crompton were substituted with the happiest results, as will be seen hereafter. The field magnets of these two machines are the original ones, and are of cast iron. The length of the space for winding on each arm is 1ft. 9in. by 1ft. 10in. wide. The cross section is elliptical in form, 6 3-16in. being the thickness at the thickest place. The length of the tunnel in the pole pieces in which the armature revolves is 36in., and is cored out to a diameter of 14½in. The winding is in shunt to the armature. The resistance when warm is about 6·5 ohms. The armatures are 36in. long by 14¼in. diameter over all, and are made as follows:—

The steel spindle is grooved or slotted out longitudinally to carry eight radial bars or longitudinal spokes.

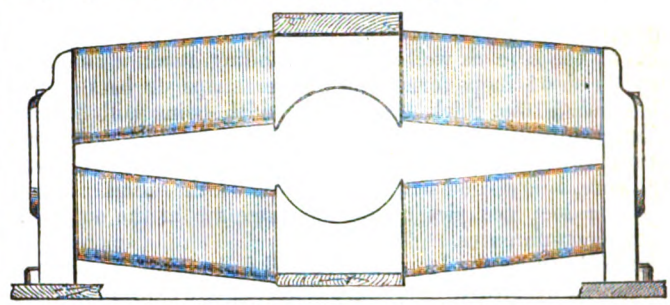


FIG. 1.—Field Magnets at the Victoria Installation.

The outer edges of these spokes are shaped into dovetails, and the iron core, which is exceedingly massive in its proportions, is carried by these radial bars somewhat as follows:—

The core consists of a large number of thin rings or washers of best annealed Swedish charcoal iron, insulated from one another by discs of asbestos paper. They have eight dovetail notches stamped on their inner edges to correspond with the dovetail projections on the radial bars above mentioned.

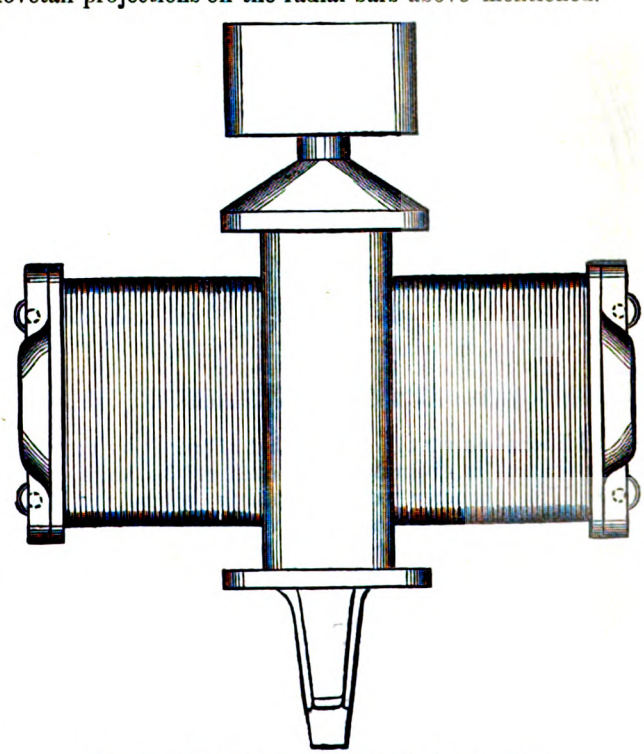


FIG. 2.—Field Magnets at the Victoria Installation.

These discs are slipped on to the radial bars, the notches sliding along the dovetail shaped edges until the full length is made up; they are then secured by the ends of the radial bars being riveted over on to end discs, which are somewhat thicker than the other discs.

At regular intervals spacing strips are inserted, giving spaces for ventilation. The strips are so formed that each ventilating space acts as a fan to pump air from the interior of the ring and throw it outwards, the spacing strips being curved as fan blades of the most approved form for the purpose. The radial bars are of the toughest phosphor bronze, the tensile strength of which is about 40 tons to the square inch, so that

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the combined spindle, radial bars, and ring core constitute a complete cylinder of enormous strength, both to resist the strains due to tangential inertia, or what is commonly called centrifugal force, and further to resist the enormous torque or driving strain which has to be transmitted to the core from the belt. To further this end the fitting of the radial bars both to the grooves in the steel spindle and to the notches in the discs has been carried out with extreme care, all surfaces being shaped together.

The insulation of the core is carried out in a peculiar manner, so that although the copper bars forming the winding are kept thoroughly insulated from the core itself, yet the insulation itself in no way interferes with the passage of the ventilating current of air, which has free access to every part of the surfaces of the core as well as of the winding itself. The latter consists of 64 loops formed of copper strips or bars, 9-16in wide and 3-16in. thick, the greater width being laid flatways or longitudinally on the outer periphery of the arc; but the return side, which passes through the central space of the ring core, is arranged with its greatest width radial. In this way the loop occupies about the same arc at the outer and inner circumferences.

In both places the loops are spaced fully 3-16in. apart, and are spaced by insulating tubes formed of hard vulcanised fibre. Otherwise these loops are left bare of insulation, but are painted black to promote radiation of heat. The resistance of the armature is ·0096 ohm. The resistance, therefore, of the field magnets is 670 times that of the armature.

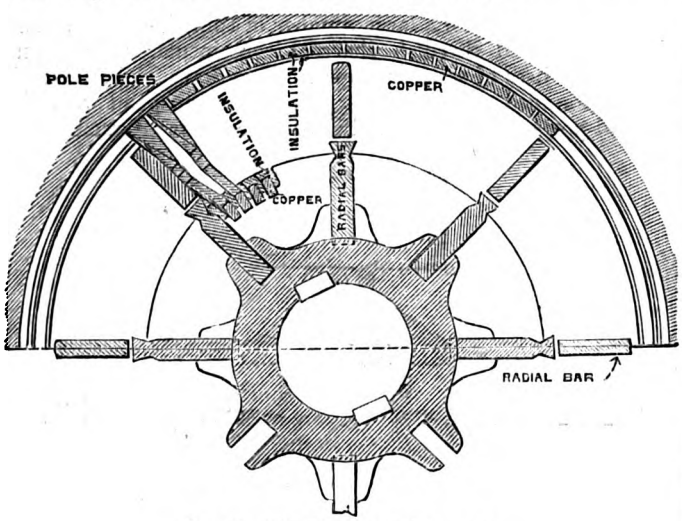

FIG. 3.—The Crompton Armature.

An additional current of air to that afforded by the ventilating space fans is given by the spokes of the large driving pulleys, 17in. diameter, being shaped as helical fan blades. This forces a strong current endways through the armature, and allows of a very large current being passed per square inch of section of the copper winding strips.

The commutators call for no particular description. There are three pairs of brushes, each of which can be rewound or exchanged during the time the full current is passing.

The maximum output of each machine is about 500 amperes at 116 volts, the speed being 900 revolutions per minute; and at this large output—which is equal to 58,000 watts, or 950 60-watt Swan lamps—there is absolutely no sign of sparking at the brushes. The commutators have acquired a beautiful dark surface polish, and the wear of brushes appears to be almost entirely prevented.

The electromotive force of each machine can be varied within considerable limits by the interposition of a rheostat of iron wire in the circuit of its exciting current. Slate boxes containing the rheostats are arrayed against the wall of the dynamo room.

The currents are conveyed from the brushes of the two machines to a pair of large switch-boards of very simple construction.

They consist of four bars of copper of double dovetail or dicebox section. These bars measure 1in. × 1¼in., and are surfaced up bright. The part that enters the backing is held firmly in position by being wedged in with beechwood wedges, cut endways of the grain and soaked in paraffin.

The framework of these switch-boards is cast iron, but the copper bars are perfectly insulated from the cast iron by the beechwood wedges, which form a continuous lining to the grooves in the cast iron. The leads coming from the dynamos are jointed into socket heads, grooved out so that they can be slipped on to the dovetailed section of bar, and there be held in position by copper wedges. The sockets and wedges are surfaced so as to fit the bars very accurately, and in practice it is found that these joints keep perfectly cold even when the largest currents are passing through them for eight or nine hours at a time.

A portion of one lead from each machine is shunted round a Crompton and Kapp current indicator. Each of these two indicators were calibrated in position after the permanent connections had been made, and there is every reason to believe that they still continue to give extremely accurate readings. The accurate and constant measurement of such large currents has been hitherto a great source of difficulty, but in this case the current given by each dynamo can be read off at a glance by any one entering the dynamo room, and the least inequality due to shifting of belts or other cause can be at once detected and remedied.

The dynamos are placed on the floor of the room, and are kept in place by oak chocks, bolted to floor, so arranged that they can be forced back for the purpose of tightening the driving belts by a screw-jack placed in front of each machine. The driving belts are double, and are 10in. wide. The current is led away from the bars on the switch-board by two pairs of cables, each consisting of 19 strands of copper wire, ·200in. in diameter. The total loss in these cables when all lights are on (one pair only being in use at present) is about 4 volts, and the electromotive force at the distant switch-board in the railway station is kept constant within one volt on either side of the standard of 112 volts by the Willan electrical governors, which control the speed of the main engines, and which we propose to describe when we come to the engines themselves.

LAUNCH OF THE "MAGNETA."

An interesting launch was made on Saturday, the 20th December, of a new cable steamer, named the "Magneta," from the building yard of Messrs. Robert Napier and Sons, Govan, Glasgow, the property of the Eastern Extension, Australasia, and China Telegraph Company (Limited), of 66, Old Broad-street, London.

This vessel is entirely built of steel, under special survey at Lloyd's, 100 A1, the boilers and machinery being certified by the Board of Trade.

We shall publish with our first issue in January plans of this fine vessel, with a full description of her cable tanks, cable machinery, and other recent improvements.

The speed of this vessel is estimated at thirteen knots, on a very small consumption of fuel, her engines being of the most improved style.

The vessel is sub-divided into cellular watertight compartments under cable tanks, engines, and round tunnel, all independently connected by a complete system for pumping up and pumping out these tanks while at work laying cable.

The cable tanks are likewise connected to the engine room donkey pumps and with steam-driven Downton pumps for discharging water in tanks overboard, and for other purposes. The vessel has condensing appliances for distilling 5,000 gallons of water daily, which, should the vessel be required at any time for trooping purposes, would be a desirable feature.

The cable tanks are four in number, being built on the top of the water ballast tanks.

The vessel has three watertight compartments forward, besides the ordinary bulkheads, so that in the event of one compartment being punctured the vessel would still be safe.

The engines are 100 horse-power, compound boilers, being built wholly of steel by the same eminent firm.

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The windlass, steam winches, steering gear, and sounding gear are of the newest design, by first-class manufacturers.

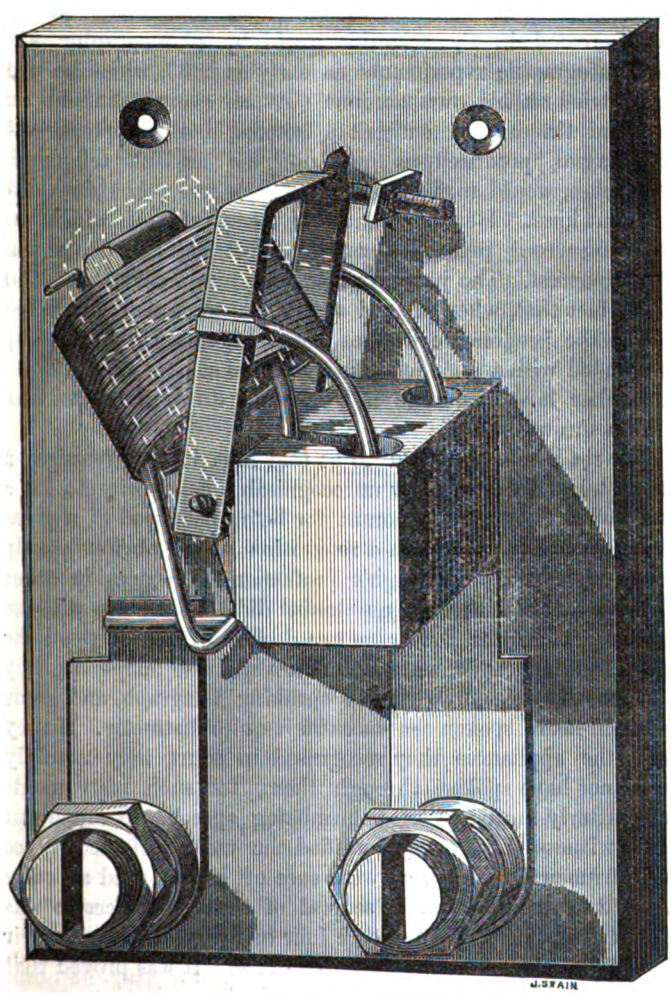
The cable machinery consists of a compound duplex machine with rolled steel frames, with steel cranks, helical wheels, so arranged that picking-up and paying-out can be going on at the same time. This gear is manufactured by Messrs. Johnson and Phillips, of Victoria Works, Charlton, Kent.

The vessel is lit up with upwards of one hundred 20 candle-power incandescent lamps, dynamo engines, and four dynamos and search lamps by the same firm. The "Magneta" will make her trial trip about the 1st of February next, and will afterwards proceed to the Thames to take in cable for Singapore, her destined headquarters.

The vessel is built to the design of Joseph Birnie, of 3, Fenchurch-avenue, London, and we trust will form a creditable addition to the company's fleet. We purpose publishing also the plans of another cable steamer, of somewhat different construction, now almost ready for launching, built by the same firm for the Eastern Telegraph Company, Limited.

THE CUNYNGHAME—WOODHOUSE AND RAWSON AUTOMATIC CUT-OUTS.

A few years ago, when incandescent lamps first came into use, several accidents occurred from the overheating of the



The Cunynghame-Woodhouse and Rawson Cut-Out.

insulated wires when more current passed through them than they were designed to carry. The use of small pieces of lead wire, or fusible cut-outs, which the Edison Company still use, was introduced to obviate this defect. These were afterwards improved upon by several makers, notably Mr. Killingworth Hedges and Messrs. Woodhouse and Rawson. The former in the place of lead used an alloy, rolled out into very thin strips and cut into shape. These strips are protected from mechanical injury by the use of thin pieces of mica. The ends of the strips of alloy pass under pieces of brass screwed down tightly upon them. When more current passes through them than they are designed to carry they are melted, and the circuit broken. Messrs. Woodhouse and Rawson's fusible cut-outs were of the same nature, except that the alloy was fastened on vulcanised fibre and then stamped out to the shape required. The face with the foil was placed downwards, thus guarding it from mechanical injury. Contact was made by two screws, screwing on to the vulcanised fibre pressing the alloy on to pieces of brass. Besides this objection—loss of power and change of melting point through heating—fusible cut-outs are objectionable, because it is impossible to test each plug, and often a considerable variation is found.

Mr. Cunynghame, the author of the well-known book on Electric Lighting, and Messrs. Woodhouse and Rawson have lately brought out an automatic cut-out, which is used in all cases where it is required to sever or make an electric connection when the current or E.M.F. exceeds or falls below a given strength. Its action depends upon the raising of an armature against the action of gravity when the current passing round a small magnet exceeds what the instrument is intended to convey. When the armature is attracted it pulls two copper legs out of two mercury cups, thus severing the connection. The moment before the connection is severed the armature falls over by its own weight to the other side of the electro-magnet, and completely breaks the circuit. Two legs can be put on to the other side to fall into mercury cups and put in a resistance, ring a bell, or do any other work required. A small screw enables the instrument to be set for any current which the size of the wire on the electro-magnet allows. A touch of the finger, or a mechanical arrangement to act after a few moments restores the connection when it is broken. In fixing the instruments, the only precaution needful is to level them; they will then remain in perfect order for years. Little or no electric energy is consumed or lost by the apparatus, as happens with the fusible cut-outs, which, when the current passing through them is near the breaking point, get extremely hot and offer an increased resistance, thus wasting energy. The advantages of an efficient automatic cut-out in connection with shiplighting are particularly apparent. The form described above is not quite suitable, as the motion of the ship has to be considered. A special form in which a spring action is used in place of gravity is made for such purposes.

THE COMMITTEE ON THE ELECTRIC LIGHTING ACT.

The first meeting of the General Committee formed at the instance of Lord Thurlow, chairman of the Anglo-American Brush Electric Light Corporation, was held on Wednesday at the offices of that company. Among those present were Sir Charles Bright, vice-president of the Society of Telegraph Engineers and Electricians; Sir David Salomons, Bart.; Professors Silvanus Thompson, George Forbes, and W. E. Ayrton; Colonel Steuart, Major Flood-Page, Captain Douglas Galton, C.B.; Messrs. J. S. Sellon, R. Hammond, J. W. Swan, R. Campbell, H. Cunynghame, J. I. Courtenay, A. H. Renshaw, F. Ince, and Frank Wynne. Letters of apology for absence were read from Lord Thurlow, Sir Frederick Bramwell, Professor Jamieson, Professor Fleeming Jenkin, and others.

In the unavoidable absence of Lord Thurlow, Mr. J. S. Sellon was voted to the chair; and on the motion of the Chairman, seconded by Mr. Hammond, Mr. E. Garcke was unanimously elected hon. secretary to the committee.

The following names were added to the General Committee:—Shelford Bidwell, E. W. W. Edwards, Clement Higgins, and Musgrave Heaphy. It was then proposed and carried that an executive committee be appointed to prepare draft clauses to be submitted to the Board of Trade, and the following gentlemen were elected by ballot to constitute the executive committee:—Sir Frederick Bramwell, Mr. J. S. Sellon, Mr. R. E. Crompton, Captain Douglas Galton, C.B., Major Flood-Page, Mr. R. Campbell, Mr. R. Hammond, Mr. J. Irving Courtenay, and Mr. J. Staats Forbes, with Lord Thurlow as chairman and Mr. E. Garcke as honorary secretary, to whom any communication may be addressed at 112, Belvedere-road, Lambeth, S.E.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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THE DRAWBAUGH TELEPHONE CASE.

The decision in the action "Bell *versus* Drawbaugh" has just been delivered, and by the courtesy of our American contemporary the *Electrical World* we are able to put our readers in early possession of the leading points in this remarkable case. We hope shortly to find space in our columns for a full report of the judge's deliverance. The interests which were at stake are said to be not less than one hundred million dollars, involving as they did the proprietorship of the Bell Telephone system, whose vast dimensions may now be said to be conterminous with the whole civilised world. The originality of Bell's invention remained unchallenged until its pecuniary value proved too great a prize to be let pass without challenge. After some insignificant skirmishes, which were easily swept aside by Bell's invincible forces, a formidable assault was at length planned under the flag of Mr. Drawbaugh, with plenty of material in the shape of hard cash and loose swearing to back him, but with the result, after a stubborn contest, that he and his confederates are driven ignominously from the field.

The story of the Drawbaugh telephone deserves to rank foremost in the history of modern imposture. Whether it was conceived in fraud or in conceit may always remain a moot point; and at what stage conscious deception took up the cue which unconscious self-delusion had manufactured it is difficult to say. To all appearance this stage was reached at the moment when capitalists envious of the fortunes of Bell's invention were looking out for a pliable tool to enable them to deprive it of its legal status or frighten its owners into paying black mail. Be that as it may, however, Mr. Drawbaugh was found. This gentleman is a professional inventor, or, perhaps, we should say rather, he professes to invent. Between the years 1865, or thereabouts, till 1874 he appears to have lived, at least partly, by inventions, which, although they generally failed, and were often mere copies, helped to keep him in easy, if precarious, circumstances. But he made nothing by telephony until 1878. In that year he wrote a memoir of himself, anonymously of course, in one of the local county guides, curiously illustrative of the American saying, recently quoted by Mr. Preece, that Modesty is a great virtue, but you can do a vast deal better without it. Here Drawbaugh is described as the inventor of many things, and as occupying "a proud position at the head of prominent men in Cumberland county." Incidentally he mentions that several kinds of telephones had "engaged his attention." But this was two years after Bell's discovery. In 1874-6 Drawbaugh's business card had been hardly less candid as to his merits; but it says nothing about his telephonic achievements. In 1878 he was interviewed by *The Baltimore American*, but made no claim even then to having forestalled Bell's invention. It must have been after 1878, therefore, that he became aware that he had discovered the electrical talking machine ten years before.

Now, it is on record that he had a string telephone in his brother's shop at that remote date, and that some stir had been created in the scientific world by phonographic and phonautographic experiments as early as 1863, which he probably tried on his own account. At all events the old tea cup and tin canister without a bottom, both supplied with diaphragms, produced as proof of his ancient telephonic researches, would answer quite as well for researches of a quite different kind. He had invented an electrical clock which was made on wrong principles, and his electrical knowledge was of the poorest. The judge, in fact, calls him a charlatan; and it is a fact that, when pressed at the trial to explain what led him to the progressive devices which began with the tea cup and ended with a telephone, he was quite at a loss. "I don't remember how I came to it." Neither do we, but we can form a shrewd guess.

Our readers hardly need to be told that it only requires a string telephone and a few unrecognisable accessories to get a reputation among the ignorant for being possessed of a great electrical discovery. Such a reputation would obviously help to improve Mr. Drawbaugh's professional ventures in other directions; and this he no doubt did. Otherwise we can hardly account for 200 witnesses declaring that between the years 1865 and 1876, when Bell discovered the telephone, they had actually seen Drawbaugh's speaking telegraph, and some of them heard spoken sentences on it quite distinctly. If they used the appliances they recognised in court they certainly could not have spoken through them, for such instruments were utterly incapable of transmitting speech. Numbers of other witnesses, however, identified the more perfected types of instruments, which they were sure of having used as early as 1872 or earlier. But in several of these instances it was shown that the witnesses were four or five years out of their reckoning, which makes all the difference. It was proved that Drawbaugh borrowed a genuine telephone instrument at Harrisburgh as soon as it came into use in his part of the country, and studied it at home for several days. This or a copy of it no doubt astonished the natives, and left far deeper impressions on their memories than the exact dates of their visits to the inventor's emporium.

The testimony of these witnesses is, however, vitiated by the inventor himself, who in fact acted as if he knew nothing of the discovery they confidently give him credit for. He was

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frequently taking out patents, but he never took a patent for this; he was in communication with patent agents, he had constant negotiations with promoters, he could command capital for his other inventions, but he never solicited anybody for his "talking telegraph," the perfecting of which "was to have made his fortune." So he is reported to have said; but this was to the ignorant and non-electrical community. To the really well informed persons with whom he had many dealings during the period in dispute he was absolutely silent about it. He professes to have been too poor to secure his invention by patent. But this was proved to be false; and he was certainly not too poor to secure a lot of worthless inventions, and he did not hesitate to seek help when he had anything worth spending money upon. He claims to have had in 1872 a telephone more perfect in its details than Bell's first instrument, patented four years later, yet he showed it only to the ignorant, spent not a penny in protecting it, and forgot to say anything about it to the only people who could appreciate its value. What other inference can be drawn from all this than that, although he may have possessed some experimental toys which had amused himself and secured the wonder of his ignorant patrons, he had really contrived nothing in the telephonic line of experiment that was worth patenting? The Court did not believe Drawbaugh's evidence to the contrary, and neither do we.

The proprietors of the Bell Telephone are to be congratulated on having escaped a grave peril. The gravity of the case against them cannot be fully estimated from the foregoing brief outline. There were fully two hundred witnesses to be combated besides the audacious testimony of the claimant himself. That the rightful owners have completely upset the conspiracy once and for all is now almost certain; and the world of invention owes them a debt of gratitude for contesting inch by inch and finally defeating one of the most elaborate and cunningly devised attempts at piracy yet on record. It is much to be regretted that the instigators and abettors in this nefarious business cannot be unearthed and brought to justice.

CORRESPONDENCE.

PAYING FOR SPECIFICATIONS.

[We understand that Messrs. Mackenzie and Brougham's objection in "Engineer's" letter, as published in *The Electrician* of Dec. 6th, is to the first paragraph. We, on behalf of the writer of the letter, unconditionally withdraw the first paragraph of that letter.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been much interested in the correspondence on the above subject, and quite agree with you, sir, that the action of Sir Coutts Lindsay has resulted in the refusal of "almost every company and firm of repute" to tender for the electric lighting of the Grosvenor Gallery.

Why should Sir Coutts Lindsay or anyone else question the *bonâ fide* intentions of those who submit estimates? Mr. Crompton very pertinently puts it in his letter of the 11th inst. that the expenses of those engaged in electric light engineering are very considerable; but does Sir Coutts Lindsay imagine that we send in tenders for amusement?

My experience of installations carried out in the manner it is proposed to light the Grosvenor Gallery is a very unsatisfactory one. One contractor supplies the engines and boilers, another the dynamos, another does the wiring, another supplies the lamps, &c., and if anything goes wrong, as it generally does in such cases, one contractor throws the blame on to another, and it becomes difficult to ascertain who is really at fault. I maintain that the complete installation for lighting the Grosvenor Gallery ought to be carried out by one electric light engineer or electric light firm, as unless this be done I cannot see how it is possible to guarantee the installation satisfactory.

The letter of Messrs. Lewis and Lewis, published in your last issue, is to my mind amusing, as I fail to see anything libellous in the letter of "Engineer." It may be that the letter was, as Mr. Crompton says, "unnecessarily harsh;" but I am one of those people who believe in "hitting the nail" with a good hard blow, and "driving it home."

Should an action for libel be commenced against you I am sure you will be well supported by a large number of those interested in the subject, and shall myself be happy to contribute my "mite" for the defence of such action.

I may just add that I am not one of the unfortunate individuals who have recently lost £3.—Yours, &c.,

Bowdon, Dec. 16, 1884. CHARLES LEVER.

[It will be seen that the paragraph containing the objectionable expression has been withdrawn, leaving the argument before us unchanged. We have not withdrawn it from fear, but simply that we have no desire to hurt anyone's feelings, even by proxy. We are sure that "Engineer" intended merely to "hit hard, hit straight, and hit fair," to which favour he is justly entitled.]

A LAWYER'S SUGGESTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is more than forty years since I signed the roll of the Queen's Bench, and amongst other victories and many defeats I obtained a unanimous judgment of the House of Lords and the Judges who were summoned reversing the unanimous judgment of the Queen's Bench and a divided judgment of the Exchequer Chamber. I am therefore not altogether destitute of experience. Permit me through your columns to suggest to would-be plaintiffs who are desirous of courting the risks not only of a verdict for the defendant but the still more probable verdict (even in the most sanguine view) of one farthing damages, that in the first place they should remember of what they complain, and in the next place that they should ask their solicitors two questions—first, what amount of damages they will guarantee; secondly, what is the limit they will place on their costs. If they can get an answer to these two questions, which I certainly very much doubt, then I do not fear that the answers will greatly cool their ardour. I don't think it would pay, even as an advertisement. —Yours, &c., J. A. S.

Notting-hill, Dec. 18th.

THE WATT AND HORSE-POWER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I cannot admit that Angelina's general deduction that velocity is distance, and that work, force, and momentum are the same, is quite fair. Granted that the second is unit time, then unit velocity is unit length, and unit momentum is unit force. Granted the foot is unit length, then unit work is unit force; and both second and foot being unity, then units of force, momentum, and work are the same. Granted, also, a unit, Angelina in a unit universe and the Spencerian hypothesis *might* be true dynamically, but let another unit rush in (not in unit time) and both the hypothesis and Angelina's unity would be destroyed.—Yours, &c.,

EDWIN.

CHEAP ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could you kindly inform me through your valuable paper the best and cheapest form of accumulator to light a small scarf pin lamp, giving about two volts, and also where such accumulators are to be obtained? I have tried several was of lighting the lamp, but have always failed to get any good result.—Yours, &c., F. L. C.

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MEASURING THE EARTH RESISTANCE OF LIGHTNING CONDUCTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. W. H. Whitehouse will find all the information he wants about "Fahr. Zero" method, &c., in Munro and Jamieson's "Pocket-Book of Electrical Rules and Tables," Second Edition, at pages 141, 142, and 182 to 184.—Yours, &c., ZERO.

ELECTRO-DEPOSITION OF BRASS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Could you, through your valuable paper, give me a receipt for making a solution for electro-brassing, also how to work the same, with amount of battery required? I should not have troubled you, only seeing such valuable information in your paper I thought you might assist me.—Yours, &c.,

27, Church-road, Seaforth, Liverpool. H. HAILEY.

THE ELECTRIC ARC.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to hand you the results of a series of experiments on arc lamps made in October last, which, in connection with the discussion now being carried on in your columns, may interest some of your readers. These results I have not before published, my intention having been to completely revise the whole of them, and to add the results of several others of equal importance. As I have had no opportunity of doing so, it may be perhaps advisable to place before your readers the results obtained pending the revision and completion of the experiments.—Yours, &c., W. B. ESSON.

European Telegraph Works, Dalston,
Dec. 6, 1884.

EXPERIMENTS WITH ARC LAMPS, OCT. 16, 1884.

Top carbon positive 13mm. diam. Hardtmuth's soft core. Bottom carbon negative 11mm. diam. Wallace diamond.

The image of the carbons was projected on a screen, and the length of the arc measured accordingly. The length of the arc is given in the tables in inches.

In the first set of experiments the current was by the introduction of compensating resistances in the circuit kept constant, and the E.M.F. corresponding to each different length of arc was observed.

The results were as follow:—

TABLE I.

Amperes.	Volts.	Length of arc in ins.	Remarks.
20	38	·06	Burning quietly.
20	42	·11	"
20	45	·24	"
20	49	·32	"
20	52·2	·44	"
20	56	·54	Slight flame but quiet.
20	62	·68	More flaming.
20	69	·90	Still more.
20	69	1·00	Flickering and unsteady.
15	39	·12	Burning quietly.
15	47	·25	"
15	50	·32	"
15	54	·44	Slight flame.
15	58	·54	Flickering and unsteady.
15	65	·72	" "
15	66	1·08	" "
15	74	1·40	" "
10	36	·06	Burning quietly.
10	41	·08	"
10	52	·24	"
10	56	·36	Flaming slightly.
10	58	·50	Considerable flame.
5	34	·07	Burning quietly.
5	38·8	·12	"
5	47·0	·20	"
5	52·6	·32	"
5	56·0	·48	"

In the second set of experiments, the difference of potential at the terminals of the lamp was kept constant, and the current corresponding to each different length of arc was observed. This set I consider very unsatisfactory. However, I copy them as they stand:—

TABLE II.

Difference of potential.	Current	Length of arc in ins.	Remarks.
60	24	·88	Quiet.
60	20	·56	Flaming.
60	18	·56	Increased flaming.
60	16	·54	"
60	14	·56	"
60	12	·54	"
60	10·5	·52	"
60	8·5	·46	Went out.
50	27	·70	Slight flickering.
50	21	·32	"
50	18	·24	"
50	15	·22	"
50	12·5	·21	Flaming.
50	10	·21	Increased flaming.
50	6	·18	Went out.
40	27	·57	Burning quietly.
40	24	·16	"
40	19	·14	"
40	17	·12	"
40	14·5	·13	"
40	12·5	·14	Slight flicker.
40	10	·14	More flickering.
40	7	·16	Very unsteady.

A third set of readings was obtained in which the length of the arc was maintained constant, and the corresponding E.M.F. and current read off, giving the following results:—

TABLE III.

Amps.	Volts.	Length of arc in ins.	Remarks.
23·5	66	·96	Flaring.
20·4	68	·96	"
15·0	70·6	·96	"
12·4	74·4	·96	Very unsteady.
10·0	74·0	·96	Went out.
24·0	54	·64	3 inch flame.
21·5	59	·64	"
19·0	62·4	·64	2½ inch flame.
16·0	64	·64	"
10·0	70	·64	Steadier.
8·5	70·4	·64	Unsteady and flared out.
24·6	43·4	·48	Fairly steady.
20·0	52·2	·48	Slight flicker.
18·0	54·0	·48	"
14·5	58·0	·48	Worse.
12·5	61·0	·48	Flaring.
8·5	65·0	·48	Flared out.
25	45	·32	Fairly steady.
23·5	48·4	·32	"
21·2	50·4	·32	Slight flicker.
21·0	51·0	·32	More.
19·4	51·4	·32	More.
14·0	53·0	·32	More.
12·5	54·0	·32	More.
11·0	55·0	·32	Very unsteady.
9·0	57·0	·32	Went out.

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Amps.	Volts.	Length of arc in ins.	Remarks.
23·6	38·0	·16	Burning quietly.
23·0	10·0	·16	„
23·2	41·2	·16	„
21·0	41·6	·16	„
20·0	42·4	·16	„
19·0	43·4	·16	Slight flicker.
14·5	46·0	·16	Rather more.
11·5	48·0	·16	„
9·5	48·0	·16	„
6·5	52·0	·16	Went out.
23	30	·1	Light steady, but carbons mushrooming.
22	32·4	·1	
21·5	34	·1	Arc too short to measure properly.
20	36	·1	
18·5	38	·1	Flickering.
18	40	·1	„
15	36·4	·1	„
13	36	·1	„
8·5	42	·1	„

It is almost unnecessary to add that the lamp employed for the above experiments was regulated by hand, as no lamp made could fulfil the requirements of the tests. It will be observed that these results bear out the truth of much that Mr. White has said regarding the behaviour of arc lamps.

AN ELECTRIC TRAMWAY.

We had this week an opportunity of witnessing some trials made with a tramcar propelled by electricity on a short experimental line laid down in the yard of the Electric Power Storage Company. About the line we need not say much; it is as rough as can possibly be imagined, and contains within its short length of 400ft. as many nasty bits as if it were put down for the express purpose of making locomotion as difficult as possible. This, indeed, was the object in designing the line, as it was thought necessary to test the system under the most unfavourable condition. In the middle of the length there is a curve of 35ft. radius, the line at the same time rising 1 in 40, so that it is impossible to make a rush for the hill. The gradient of the line increases from 1 in 40 at the curve to 1 in 17 at the end. It is needless to say that so steep a line could not be worked with horse traction, and that the task which Mr. Reckenzaun, the inventor of the system, has set himself is more severe than necessary. The car is propelled by two of Reckenzaun's motors, driven by accumulators placed on trays under the seats. For the convenince of quickly changing the cells the trays run on rollers, and a special trolly is brought up to the car, on to which the exhausted cells are pushed. The same trolly serves to bring the new set of cells up to the car, and all the work of changing cells can be performed by one man in about the same time as would be required to change the horses with an ordinary car.

A most ingenious arrangement of compound switch enables the driver to get a variable power—from four to sixteen horse-power—out of the two motors collectively. The motors, gearing, and accessories weigh only about 10cwt., whilst the accumulators weigh about 1¼ ton. These weights compare most favourably with the weights of a steam or compressed air locomotive of equal power, and the absence of steam, smoke, and noise is also a strong point in favour of electrical traction. During our visit Mr. Reckenzaun started the car without difficulty on an incline of 1 in 30, and the speed obtained on the level can vary from 3 to 10 miles an hour.

As mentioned above there are two motors, each capable of developing from 2 to 8 horse-power. The motors are fixed on bogies, each bogie forming a complete whole ready to be put under any ordinary car. The great advantage of this arrangement is that existing rolling stock can be transformed for electrical traction with great facility, and by subdividing the weight of the motors on two bogies, and by distributing the weight of the accumulators over the whole length of the car there is no undue increase of pressure on any of the wheels, and no alteration in the permanent way is required. The car is lighted by four Swan lamps, and electric bells are fitted for communication between passengers, conductor, and driver. On each end there is the ordinary hand brake, and the driver has control over the motors by two levers—one for reversing, the other for varying the power. One charge will work the loaded car for two hours, stopping, reversing, and starting on an average sixty times an hour. The experimental line at Millwall is hardly sufficient to form a correct estimate of the cost of electrical traction, but from experiments made during the last two months, Mr. Reckenzaun has approximately computed the working cost at 3½d. per car mile. This includes 15 per cent. depreciation on machinery and 50 per cent. on accumulators.

The accumulators are a special type, made by the Electric Power Storage Company, and the whole of the work was carried out by this company to Mr. Reckenzaun's designs.

ON THE ELECTRIC LIGHT.*

BY ALFRED RICHARD SENNETT, A.M.I.C.E.

(CONCLUDED FROM PAGE 94.)

In the ordinary holophotal projectors the crater is turned in the direction in which it is desired to project the light, the divergent rays being rendered parallel by the prismatic zones of the dioptric lens; whilst, in what is known as the Mangin projector, the crater is turned in the opposite direction, and faces a concave mirror, the peculiarity of which consists in the fact that the outer and inner surfaces, namely, the silvered and unsilvered surfaces, have different degrees of concavity, the ratio of the radii being so adjusted that the inner (transparent) surface corrects the spherical aberration of the outer (silvered) one.

For ordinary industrial purposes, it is generally required to illuminate uniformly a horizontal plane at a certain distance below the arc. Reference to the diagrams (Figs. 8 to 12) will show that this is rather imperfectly accomplished by the unaided arc, since the lower or negative electrode casts a circular shadow on the horizontal plane, the area of such shadow increasing with the square of the height of the arc, which should always be great to obtain economy and uniformity in lighting. In order to obviate this difficulty, the author suggests the method of utilising the rays proceeding in upward and horizontal directions, and which are useless for the illumination of ground area, by surrounding the arc in and above its horizontal plane by an annular totally reflecting prism, having angles such that rays originally having an upward and horizontal direction are turned downwards and made to illuminate the otherwise less intensely illuminated portion before mentioned. The reflected rays may be made to take any required direction by curving the totally reflecting side of the prism. In lamps for industrial purposes, in which it is required to attain this end in an inexpensive manner, the annular prisms might be constructed of sheets of glass, filling the interior with a liquid, say distilled water.

In many instances, however, it is of more importance to diffuse the light uniformly in all directions and in such manner as to obviate the production of shadows.

Diffusion of the Light of the Electric Arc.—On account of the very small space occupied by the electric arc, and of its great illuminating power, the resulting shadows are extremely dense and well defined; and it is therefore generally found necessary to employ devices for diffusing the light.

The usual method is to place the arc within a globe of ground, frosted, opal, or alabastine glass. The globes should be of large dimensions; for, as every part of the diffusing medium becomes self-luminous and may be considered to be giving out light in all directions, it is clear that shadows, when an arc is surrounded by a diffusing globe of large dimensions, will be much less clearly defined at their edges, and will be fainter (if the object be small and moderately near the light) than if the light be naked or one provided with but a small globe.

However, the loss of light by absorption in various diffusing media has not been thoroughly investigated, and the results which have been obtained are very discordant. In measuring directly by first taking a reading of the naked light and then interposing the substance whose absorption is required to be ascertained, and afterwards taking another reading, the result is as much an indication of the dispersive and reflective effect of

* Paper read at a Supplementary Meeting of the Institution of Civil Engineers.

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that particular substance as of the light absorbed, since the intensity of the light which originally fell upon the screen of the photometer is, by the use of the diffusing medium, diminished by being caused to occupy a larger area, and also by many of the waves being turned back by reflection. The loss will therefore vary with—

1st. The distance of the specimen from the screen of the photometer.

2nd. The size of the specimen or that of the aperture through which the light is admitted to it.

3rd. Its reflective effect.

The author proved the accuracy of the first assumption by taking separate sets of readings, one set at a great and others at smaller distances from the light. The second assumption was too obvious to need verification. Figs. 13 and 14 will show this.

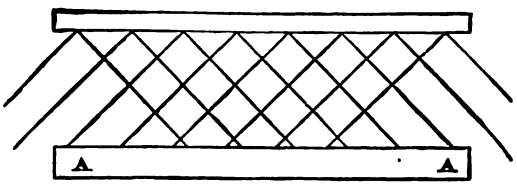

FIG. 13.

Imagine the specimen to be composed of an infinite number of bi-concave lenses, then it is evident that the amount of light falling on the given area A will vary with the first and second conditions.

Another method of diffusing electric light, which is very effective, but which is generally considered to entail great loss of light, is that in which the arc is concealed from view, the resulting light being due entirely to reflection. Doubtless a large amount of light is lost by this method, but it must be remembered that a smaller amount of well-diffused light is often quite as efficacious as a much larger amount wanting in uniformity of distribution. This is especially the case in manufactories in which delicate operations are carried on, or where machinery in motion casts moving shadows. For physiological reasons, also, this is true; for if the eye be not called upon to respond to great variations in intensity of the light, a smaller amount will suffice. If the direct rays from a powerful source of light fall upon the retina, the workman or workwoman will not recover his or her maximum

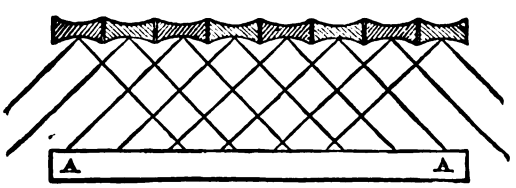

FIG. 14.

sensibility of vision for a perceptible time after. The author has made some rough experiments in this direction, and has found that the period before normal sensibility is regained is longer the more intense the light, and that this period is very considerable. He also found that it varied to a great extent with the colour of the light.

Relative Efficiencies.—The comparison of the efficiencies of the different modes of illumination is an interesting and instructive consideration, but it is one beset with considerable difficulty, as scarcely any complete set of efficiencies has been taken. The greatest difficulty, and probable point of inaccuracy, is in the photometric measurements, as the readings of the instruments used for measuring the candle-power of an illuminant depend greatly upon the difference in colour of the various sources of illumination; again, in no illuminant is the illuminating power the same in every direction. To compare the electric arc and a gas flame, for example, it must be borne in mind that the distribution of light around the source is not uniform, and that the gas flame occupies a perceptible space; obviously, then, some different arrangement is necessary for measuring the power of each light. As a way of effecting a comparison it has been suggested to take a number of readings at different angles, and to consider the average as the candle-power of the light. This meets the difficulty to a certain extent, and is the method upon which the author has based his calculations. The commercial efficiency may, however, be very different. By commercial efficiency is meant the amount of light obtained in the place where it is required. Thus, suppose A and B to give equal lights (average of all directions), and it is wished to have the greatest light at an angle of 45°, then should A give more than its average and B less than its average; A has greater efficiency for this particular place. There may even be a light which has a greater average intensity giving a less degree of illumination in one direction than that emitted from sources of less average intensity.

Other difficulties are the different illuminating powers of various gases, the different efficiencies due to the methods and temperatures at which they are burnt, and the different efficiencies of arcs of various powers.

The following table may be taken as a fair comparison of the efficiencies under these circumstances. The table is not intended to be a comparison of the costs, but only of the efficiency of transformation; the cost efficiency depends not only on the efficiency of transformation but also on the economy of the means of transformation.

TABLE SHOWING CANDLE-POWER PRODUCED PER HOUR BY 1LB. OF COAL TRANSFORMED IN EIGHT DIFFERENT WAYS INTO LIGHT.

Method of Transformation.	Gas produced.	Coal required per H.P. effective per hour.	Candles per 5 c. ft. per hour.	Gas per effective H.P. per hour.	H.P. given to dynamo.	Electrical H.P. at terminals of lamps.	Candle-power per effective H.P. at terminal.	Candle-power per hour obtained.	Rel. amount of light, taking ordinary gas burner as 1.
	c. ft.			c. ft.					
Coal gas	4·4	...	12	...	...	...	...	10·6	1·0
Coal gas, gas engine, dynamo, and arc lamp	4·4	...	...	30	0·15	0·11	1,200	126·6	11·9
Coal gas, gas engine, dynamo and incandescent lamps.....	4·4	...	...	30	0·15	0·11	200	21·1	2·0
Dowson gas, gas engine, dynamo, and arc lamp	83·3	...	...	125	0·67	0·48	1,200	576·0	54·3
Dowson gas, gas engine, dynamo, and incandescence lamps	83·3	...	...	125	0·67	0·48	200	96·0	9·0
Steam engine, dynamo, and arc lamp	...	2½lb to 4lb	...	...	0·40 to 0·25	0·29 to 0·18	1,200	348·0 to 216·0	32·8 to 20·4
Steam engine, dynamo, and incandescence lamps ...	...	2½lb to 4lb	...	...	0·40 to 0·25	0·29 to 0·18	200	58·0 to 36·0	5·5 to 3·4
Siemens burner, ordinary gas	4·4	...	30	...	...	...	...	27·0	2·5

It should be remembered in reviewing the above table, that on account of its showing the light produced by 1lb. of coal the by-products resulting from the production of ordinary coal gas cannot be considered. If it had been a consideration of the cost efficiencies instead of light, the efficiencies of Nos. 1, 2, 3, and 8 would have been much higher, as in this case the value of the by-products might have been taken into account.

Data assumed, efficiency of dynamo... 80 per cent.
,, efficiency of cables ... 90 ,,
,, good steam engine..... 2½lb. of coal per effective horse-power per hour.
,, average ,, ... 4lb. ,, ,,

The Electrodes.—When the arc is produced in air (which is always the case when employed for industrial purposes) the carbon electrodes are gradually consumed in the ratio of about 1 part of the negative to 2 parts of the positive. This consumption is due to the gradual oxidation of the heated points, and to the complete combustion of the moving particles which are projected chiefly from the positive towards the negative.

Now, since the great efficiency of the electric arc consists in its ability of condensing into an exceedingly small space a large amount of heat, it is advisable to employ as electrodes a carbon of very low thermal conductivity in order to localise the heat as much as possible, so as to increase the light and prevent oxidation at a temperature too low to produce light; at the same time the electrical conductivity should be as high as practicable.

Purity, hardness, and homogeneity are the chief desiderata in a good carbon. Out of seven specimens of carbon of well known make the author found the most light to be produced by the one

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containing the least amount of impurities. The following shows the amount of ash in each :—

	Per cent.
S	12·45
E C C V	5·35
G *y*	3·72
B	3·50
C C C *d*	2·80
C	2·84
G *n* (original Gaudoin)	1·80

The purest carbon, and that giving the highest efficiency, was the last, which was made by M. Gaudoin. The others are at present in the market, and the author abstains from giving the names. The redness of the ashes affords an approximate indication of the amount of iron contained in each specimen. All attempts to increase the illuminating power of the arc, by the introduction of various materials during the manufacture of the carbons, have failed, as the decomposition of such materials produces gases which, at the high temperature of the arc, become conductors. Several methods of preventing the wasting away of the carbons have been patented. One with which the author was connected consisted in surrounding the electrodes with a hydro-carbon vapour, which, at the high temperature of the arc, became decomposed, and a very hard carbon was deposited upon the electrode; but it was found that the heated gas increased the conductivity of the arc, and the loss of light was very great. In order to obviate the employment of mechanism, and the necessity of frequently renewing the carbon rods, the author attempted to substitute for the solid electrodes powdered carbon contained in large vessels connected with metallic tubes, furnished with non-conducting nozzles of very refractory material. A current of great electromotive force, however, was required, and the light was of a violet hue. As a means of obviating the necessity of repeatedly renewing the carbons the author constructed a lamp which made its own electrodes as required. The lamp contained two cylinders provided with plungers which were forced in by a powerful spiral spring, the uncoiling of which gave motion to nut-wheels working on screwed prolongations of the plungers. It was, however, intended to substitute for this in practice a heavy weight descending within the lamp column. The cylinders were filled with powdered carbon mixed with treacle, and one end of each cylinder was provided with a 13-millimetre hole, which acted as the draw-plate employed in the manufacture of carbons. The direction of the carbon rods was controlled by two guide-tubes pivoted at one of their extremities to the covers of the cylinders. These tubes were inclined to each other at an angle, and motion was imparted to them (in order to regulate the length of arc) by means of a solenoid and plunger, the feed being given by the train of wheels driving the plungers, thereby increasing the length of the electrodes. The action of the lamp was satisfactory, but in this, as in the previous instance, the light was blue, owing probably to insufficient density of the electrodes. Coating the electrodes with a thin layer of metal (generally copper, nickel, or iron) increases their durability.

The importance of purity and density in the carbons cannot be too strongly pointed out. No mechanism, however delicate, can be devised to produce a steady light if imperfect carbons be employed.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

The annual meeting of this society was held on Thursday, 11th inst., at the Institution of Civil Engineers, Great George-street, Westminster, Professor ADAMS, president, in the chair. In the course of the report for the past year it was announced the premiums for papers read before the society had been awarded as follows:—The Society's premium of £10 to Professor G. FORBES, the Fahie premium of £5 to Dr. W. H. STONE, and the Paris Congress premium of £5 to Mr. H. C. MANCE. Honourable mention also was made of Mr. W. Mordey's paper. Many valuable additions had been made to the library during the year, chiefly by liberal donations of friends of the society through the instrumentality of its indefatigable librarian, Mr. FROST. The report being adopted, votes of thanks were passed by the meeting to the Institution of Civil Engineers for the continued loan of its rooms to the society; to the honorary secretaries of the society abroad; to the honorary treasurer, Mr. E. GRAVES; to the auditors, and to the honorary solicitor, Mr. BRISTOW. Voting papers having been deposited in the ballot-box, it was taken away in charge of two scrutineers, at half-past eight; and Mr. W. H. PREECE, F.R.S., then delivered an interesting address on Electricity in America in 1884. After reference to his former visit to America, in company with Mr. Fischer in 1877, which was a purely official visit, for the purposes of the Post Office, Mr. Preece described his journey to Montreal, in company with members of the British Association, which for the first time in its history, held its meeting this year outside the boundary of the United Kingdom. Their party on board the "Parisian" was nearly 200 strong, and the route selected was by way of the St. Lawrence—a route which brought them within 200 miles of the Greenland shores, and although in the height of summer they experienced most inclement weather during a considerable part of the journey. Altogether it was not an attractive route, except to people who preferred any discomfort rather than that of a rough sea, which, of course, was greatly reduced by taking the St. Lawrence.

Arrived at Montreal, some 1,700 visitors were assembled to make up the gathering, of whom about 600 had crossed the Atlantic. The rest were Canadians and 200 Americans. Apart from the actual business of the meeting there were unlimited entertainments of a social and entertaining kind, and many admirably organised excursions to see the beauties and peculiarities of the country. Nothing could exceed the courtesy and hospitality of their entertainers, and the careful attention to their visitors' comfort throughout. The meeting itself was not, as has sometimes happened, of a specially electrical character, and no striking novelty in that field of science came to light on this occasion. Perhaps an exception should be made in respect to Professor Oliver Lodge's remarkable discourse on the seat of the E.M.F. in the voltaic cell, a discourse so fresh, so brilliant, and so lucid that it gained the admiration of everyone who heard it; and it was to be hoped that this society would have the advantage of hearing it from Professor Lodge's own lips. The conduct of the meeting was under the guidance of Lord Rayleigh, who won golden opinions everywhere as a pattern man of business, an eminent man of science, and an English gentleman. In his own department Sir W. Thomson also sustained the credit of Great Britain in the higher speculations of science.

Leaving Montreal Mr. Preece was induced, much against his will, to visit the American Association, which was holding its meeting at Philadelphia. There the heat was most intense, ranging from 100 all the daytime to 90 all the night, accompanied by American insects of a most ferocious breed. The edification in this city hardly compensated for the discomforts experienced in it, notwithstanding the unfailing hospitality of American hosts. In the course of his travels, which were pretty extensive, Mr. Preece visited Pittsburgh, where he saw the utilisation of natural gas obtained in the vicinity, and went to many other places where educational and scientific establishments have been endowed by private munificence to an extent quite unknown in this country. Wherever he went he of course made a point of inquiring into the working of telegraphy, telephony, and the electric light, the results of which he would state further on. Returning to the subject of the American Association, it was interesting to electricians only, or chiefly, in the discussion which took place on "Hall's Effect," a discussion in which, he was proud to say, our English contingent held their own with much credit to the home country. Amongst the speakers he mentioned particularly Professors Forbes, Silvanus Thompson, and Fitzgerald. The Conference of Electricians was simultaneously held during this visit. It was instituted by the U.S. Government for the purpose of discussing the decisions of the Paris Electrical Congress with reference to electrical units. Those decisions after full discussion were adopted, although the chairman, Professor Rowland, showed their inaccuracy in at least one particular, uniformity of measurement throughout the world being considered of such paramount importance as to outweigh any little departure from scientific exactness. Mr. Preece's own suggestion for substituting a standard of 1,000 watts for the horse-power was also discussed and favourably received. A discussion of some interest likewise arose on Professor Rowland's theory of the dynamo—a theory upon which there was great divergence of opinion. In this relation Mr. Preece mentioned the remarkable fact that whilst alternate current machines were preferred in this country, they were hardly known in the States, great difficulty having been experienced in obtaining one even for lecture purposes. Earth currents, atmospheric electricity, telephony and the disturbances to which it is liable, were also subjects of discussion at this Conference.

While Mr. Preece was in America the country was suffering from an acute attack of that mania from which Europe is hardly yet recovering—namely, the exhibition craze. There were exhibitions everywhere, most of them claiming to be the largest the world had ever seen. He visited many of these, and travelled over a good bit of country. He was thus enabled to form an opinion of the progress made in electrical discovery and enterprise since 1877. The extension of the telegraphic system had been very great. The wires under the control of the Western Union Company measured 433,726 miles, against 200,000 miles seven years ago, an increase, however, largely due to the wholesale amalgamations which that Company had accomplished by absorbing other large companies. But of scientific progress he could only describe it as *nil*. On his former visit he brought back many useful wrinkles; now we could, he thought, teach the Americans a good deal, which, however, they seemed disinclined to learn, displaying a marked jealousy of English inventions. An exception in this respect

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was the adoption of the Wheatstone fast-speed instrument, which had got a firm footing on American soil, and was largely used on the Western Union lines. An exception of the opposite kind—the only one deserving of special notice—was Delany's multiplex sytem, an adaptation of the French invention described to the society by Captain Webber after the Paris Electrical Exhibition. Delany has applied the ingenious principle of that discovery to Morse working, with the result that six messages could be keyed in the ordinary manner in the same direction at one time. It is to be brought here next year, and Mr. Preece could promise it a fair trial on the Government lines of this country.

As regards telephonic progress in America, we in England could hardly form any conception of the extent to which its use had spread on the other side of the Atlantic. People here complained of the restrictions on telephonic enterprise through Post Office interference [hear, hear]; but compared with the conditions they had to submit to in the States, the telephone companies in these islands were exceedingly well off [laughter]. The American local authorities took every occasion possible to tax the companies, and sometimes their impositions amounted to more than fifty per cent. of the gross earnings; whereas the demand of the Post Office here was only a modest ten per cent. The charges, too, were higher than in England. In Chicago it is £26 per annum; in Philadelphia £25; whilst in New York the "Law" system charged £44, and ordinary systems exacted £35.

Their instruments are no better, but rather worse than ours, although the exchanges are decidedly superior. As to the lines, they are as bad as they well can be in many instances. Notwithstanding the high charges and imperfect appliances, however, there are 986 exchanges, nearly 90,000 miles of telephone wire, and 517,749 telephones in use; and in New York and neighbourhood alone there are 10,600 subscribers—nearly as many as the subscribers in all England put together. The fact was, the conditions of climate, habit, social life, and commercial intercourse in the States favoured this means of communication. Messengers are expensive and almost unobtainable, and whilst we are glad of an excuse for getting outside our offices the Americans gladly lay hold of every appliance for saving physical exertion and the trouble of moving. One consequence of this extraordinary telephonic development is a villainous array of poles along the main thoroughfares, to the complete disfigurement of any architectural merits they may pretend to. In the Broadway, New York, there are six distinct lines of poles; and a more hideous set of erections cannot be found anywhere. Besides this, they are not free from danger; and while he was there he heard of at least seven cases of fire directly traceable to the falling of high tension current wires.

In conclusion, Mr. Preece remarked that as he had so recently spoken at the Society of Arts on Electric Lighting in America, there was no need to repeat his observations here. He, however, referred to Edison's achievements in this line of business, stating that as far as New York was concerned, that bold and ingenious inventor had entirely solved the problem of electric lighting. Finally, he could not help contrasting his own views of the Americans and American life with those of Mr. Capper, published in the *Pall Mall Gazette* on the previous Tuesday. For himself he had nothing but good to say of them; and at all events, he was sure that members of the electrical profession would ever find sympathy and a hearty welcome in the United States, not less than among our fellow subjects in the Canadian Dominion.

In the course of Mr. Preece's address the scrutineers returned with their report upon the balloting. With due solemnity the President communicated the result to the meeting, reading out a list of names which tallied exactly with the printed ballot list supplied by the Council,—a coincidence which evoked the exemplary applause of members who had gone through the formality of putting their papers into the box.

LEGAL.

The Gulcher Electric Light and Power Company (Limited).

On Saturday, the 13th inst., before Mr. Justice Chitty, two petitions were presented for winding up this company, one by Mr. Norton, a late director of the company, who claimed to be a creditor for fees due to him as director, and the other by Mr. Henry Crookes, the company's electrical engineer, who claimed to be a creditor for an arrear of salary, and by two shareholders. The company was formed in May, 1882, with a capital of £300.000, subsequently reduced to £150,000, in shares of £5 each. The company not having met with the success anticipated, a general meeting of the shareholders was held on the 4th inst. for the purpose of considering a report of the directors, in which they suggested a voluntary winding up, stating that they did not feel justified in continuing to carry on the company without the assent of the shareholders. A resolution was then passed adopting the report and accounts, but with some dissentients. The secretary of the company in an affidavit in opposition to the petitions stated that the company was perfectly solvent, and that it was their intention to take proceedings against their late directors for alleged negligence and misfeasance, but the debts claimed by Messrs. Norton and Crookes were not actually disputed.

After a long discussion, his Lordship dismissed Norton's petition on certain terms, by which the petitioner's debt was to be secured to him on condition of his paying the calls due from him on his shares, and the company undertaking to commence an action against the directors to substantiate the charges made in the secretary's affidavit.

As to Crookes' petition, Mr. M'Naghten (who appeared for the company) offered to pay Mr. Crookes' debt, with costs, upon which terms

His Lordship accordingly dismissed that petition.

The following letters have appeared on this subject in *The Times*:—

"Sir: The Gülcher Electric Light and Power Company (Limited) has this day concluded a contract for lighting the Alexandra Palace with the electric light.

"This contract would have been signed a fortnight ago but for the two petitions to wind up the company which have been hanging over this company for the last month, and were only dismissed on Saturday.

"The case affords a striking instance of the extent to which a joint stock company's business may be paralysed by petitions of the kind. The tender for the above contract was accepted by the Palace Company on the 1st of December instant subject to our getting the petitions dismissed on the following Saturday.

"On Saturday, the 6th inst., they were allowed by the Judge to stand over for a week.

"By dint of great pressure the Palace Company were induced to keep the contract open for another week, but they distinctly warned us that under no circumstances could they keep it open beyond to-day.

"On Saturday last the first petition (Mr. Norton's) came on and lasted until the rising of the Court, when it was dismissed upon terms. As an action is now pending by the company against Mr. Norton and others affecting the fees claimed by him it would be improper to criticise this petition.

"With regard to the other (Mr. Crookes's) it was about to stand over for another week, and the alternative presented to this company was either to pay this disputed claim or to throw up the Alexandra Palace contract. Under the above circumstances, and only under the above circumstances, the company elected to pay Mr. Crookes and his solicitors' costs and get this petition also dismissed.

"With regard to your reporter's account of what took place, he has accurately stated the case of the petitioner Norton as presented by that petitioner's counsel, but he has omitted to state what also came out in evidence, viz., that so far from being insolvent, as alleged, this company has no debts; that an overwhelming majority of the shareholders opposed any winding up whatever; and that the debenture holders and alleged creditors who supported the petitions consisted, as to debenture holders, of Mr. Crookes and his family and their solicitors; and as to creditors, of the petitioner Norton's co-directors and the former solicitors of the company.

"The claims of the late Directors and solicitors have always been resisted by the present Board, and an action is now being brought against them by the company.

"I trust that in justice to this company you will insert this explanation of a report which, unexplained, is calculated to do this company serious injury.

"I am, Sir, your obedient servant,

"D. De Castro, Chairman of the Gülcher Electric Light and Power Company (Limited).

"4, Coleman-street, E.C., Dec. 15."

"Sir: We have seen the letter of Mr. De Castro, the chairman of the Gülcher Electric Light and Power Company (Limited), which appears in *The Times* of to-day.

"It is impossible in a letter to explain all the reasons which actuated our clients in presenting the petition for winding up the company, but, in justice to them, we may state that they would not have followed this course except for the report and accounts of the directors, which were forwarded to the shareholders on the 19th November last. The balance-sheet, in the opinion of our clients, showed a very disastrous state of things, and the cash at the bank appeared to consist of the sum of £17 7s. 5d. only.

"The report of the directors, moreover, stated that it was with the greatest regret they had come to the conclusion to which they had been compelled to come, and the report then proceeds as follows:—

"'That conclusion is—To submit to the shareholders at the approaching general meeting whether, in view of the circumstances above stated, the company should be voluntarily wound up, or whether its business as a manufacturing company should be modified or suspended for a time until the company has recovered from the various persons against whom it has claims sufficient money to justify it in resuming more active operations and in taking advantage of the reaction in favour of electric lighting which seems to be setting in.'

"The whole report and accounts, but specially the extract above-mentioned, as also the fact that the whole of the Board tendered its resignation, and placed the affairs of the company once more in the hands of the shareholders, were among the reasons which induced our clients to take the course they did, as they considered it undesirable that under the circumstances the liquidation of the company should be in the hands of the present Board or those nominated by them.

"We are, Sir, your obedient servants,

"Solicitors for the Petitioners.

"40 and 42, Queen Victoria-street, E.C., Dec. 16."

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COMPANIES' MEETINGS & REPORTS.

The Consolidated Telephone Construction and Maintenance Company (Limited).

The third ordinary general meeting of the shareholders of this Company, originally held on the 23rd of May, 1884, and by adjournment on the 25th of July, 1884, on which last-mentioned date the said meeting was further adjourned, was, pursuant to the last-mentioned adjournment, held on Tuesday last at the City Terminus Hotel, Cannon-street, E.C., for the purpose of continuing and completing the business of the said ordinary general meeting. Mr. C. L. W. Fitz-Gerald presided.

The SECRETARY (Mr. Charles Curtoys) read the notice calling the meeting. The further report of the committee of investigation was taken as read.

The CHAIRMAN: Gentlemen, time is money, so I do not mean to detain you long. I think I must make a few remarks first of all on the allotment of shares. It appears to the committee that that allotment was a very discreditable transaction to the late Board, and there is one thing that strikes me as very remarkable, and that is that there should have been what I must term a double allotment—one on the 22nd of April and a second on the 26th; because there must have been a reason for that, although I do not know what the reason was. You find stated in the report here that Sir Julius Vogel sent in a written application for 1,000 shares, and that he was alloted on that letter 3,330 shares, and in the allotment register this 1,000 shares was altered to 5,000, and there was no further written application made. Now, the counsel's opinion states that Sir Julius Vogel is, in respect of any shares over and above the 1,000 which he applied for, liable to the Company for the profit he made on the sale of those shares. That is very just I think if one considers it, and if you would allow me to suggest it, I am of opinion that the question of taking proceedings against Sir Julius Vogel should be left in the hands of the Board. I think by that means we may possibly find some way of getting back a sum of money for the shareholders from that gentleman. I hope we may. At all events we can but try. Now, before I go any further I should just like to say a word or two on the subject of the circular which the Directors sent round to the shareholders informing them that they thought they would be in a position to pay regularly quarterly dividends at the rate of 10 per cent. per annum. I think that is a very irregular thing to do. I do not recollect a case of the kind ever happening before. It seems to me very irregular. It certainly was likely to lead shareholders to purchase shares in the market; and then we come to the fact that almost immediately after that circular was sent round, Sir Julius Vogel was selling his shares. Well, gentlemen, I hardly know myself what to say of a proceeding of that sort. At any rate that is what absolutely happened, and I think I need say no more on the point beyond this—that we will use every endeavour to get something back from Sir Julius Vogel. Of course we do not for a moment contend that the profit was not earned. Those dividends were earned undoubtedly. There cannot be any question about that. The only question in my mind is whether they ought to have been divided so quickly. I think it would have been more prudent to wait a little to see how the Company got on before doing so. The next point that I shall make a few remarks upon is the history of the 4,000 telephone contract. We have made that history a rather long one, so that you should really be made aware of all the facts of the case, and should thoroughly understand them, because, of course, we wish the shareholders to know everything about the Company, and all that has taken place in it, and therefore we made this as full as we possibly could. But I think I should just like to tell you in as few words as I can what my idea is, and I believe I may say that the committee hold the same opinion as myself. It is this: that Colonel Gouraud, Mr. Bigelow, and Mr. Cargill have sold the Edison-Bell patent to the Oriental Company. The sum agreed upon was £50,000 in cash and £100,000 in fully-paid shares. On this transaction coming to Mr. Gower's knowledge, he said to the Oriental Telephone Company:—"Oh, I have certain rights over the Oriental district, and if you don't pay me, or in some way compensate me, I shall fight you." Now that naturally alarmed the Directors who were bringing out this Oriental Telephone Company. The prospect of a fight in the beginning would naturally frighten people away, and they would not get their capital subscribed. Then, as a means of stopping Mr. Gower's mouth, Colonel Gouraud, Mr. Bigelow, and Mr. Cargill, enter into a contract to take 4,000 Gower-Bell telephones from him, and this satisfied Mr. Gower apparently. The Edison party have smoothed over the difficulty, but they did not give the original sum asked, but only £40,000 and £75,000 in fully paid up shares. Time went on and your Company purchased Mr. Gower's business. In that business, amongst the various instruments your Company had to manufacture were the 4,000 telephones—that is the contract referred to. No doubt you paid a large sum of money for that. I tried to get out of Mr. Gower what the amount was, but he evaded that point. I wrote to him, but he would not say how much he estimated that contract at. You have seen in Sir Julius Vogel's memorandum that Mr. Gower at all events estimated it as being worth £20,000. Well now, gentlemen, you see also according to Sir Julius Vogel's statement that Colonel Gouraud from the first tried apparently to get the contract set aside. After various attempts by your Board to get the contract completed, the Company called the Telephone Supply Company came on the scene. Now, is it possible that the Directors for the time being inquired who that Telephone Supply Company were? Because if you turn to the report you will find that they consisted of Cargill, 198 shares; Chesten, 1; Cheston, 1; Hubbard, 299; McLeod, 1; Bigelow, 100; Edison, 200; Gouraud, 197; Grigg, 1; Kingsbury, 1; Allen, 1. Well, gentlemen, it seems to me very much like handing that business direct from the three purchasers of that contract to almost the same people, because they are gentlemen of the family that has been written about as "the telephone ring" in the *World* and *Truth*. It seems to me that if the Directors had inquired into the matter they would not have handed over the liability to the Company. I do not know whether they did inquire or not. However, the Telephone Supply Company came into existence, and they made one payment of £1,800, and then the Board allowed Mr. Gower to assign the Oriental patents, by which they practically lost the security which they held for the completion of the contract. I understand that they were advised to do so. I can hardly believe it. Difficulties then arose, and the United say that Colonel Gouraud, Mr. Bigelow, and Mr. Cargill cannot use the 4,000 telephones in the United Kingdom. Well, we have seen, according to the report, that the United, in the agreement, expressly stated that they could use them; but for all that there was some reason in the background why those telephones should not be used in the United Kingdom, and, strange to say, I have come across that reason within the last week only, and it is this: I have seen in the possession of Messrs. Waterhouse and Winterbottom a printed document, bearing date 8th of April, 1881, of the heads of agreement, and the names of our solicitors (Messrs. Mackrell, Maton, and Co.) and those of the United (Messrs. Ashurst, Morris, Crisp, and Co.) are not on that document. Attached to it is a schedule, and in that schedule are the 4,000 telephones put down as the Oriental Telephone Company's. Now, our schedule which Mr. Gower signed has got these 4,000 telephones entered as belonging to Messrs. Gouraud, Bigelow, and Cargill, London; but there is a query against them. What that query means I do not know. But, gentlemen, with the assistance of Mr. Morgan, of the United, I am going a little further into this 4,000 telephone case. I hoped from the first that we should get something out of it, but you see counsel tells us that on the evidence we have at present there is no case for you against your Directors, or any of the parties concerned; but I do not mean to let the matter drop. Now, with your permission, I will go to a more agreeable subject—that is, what we have been doing here in London and abroad in the various companies. The first thing the present Board did on coming into power was to endeavour to the very utmost of their ability to establish friendly relations with the United Telephone Company and the subsidiaries, which are the National Company, the Northern Telephone Company, the Lancashire and Cheshire Company, and the Telephone Company of Ireland, and I think, gentlemen, I can say without fear of contradiction that we are on most cordial relations with all these companies at the present moment. You will recollect that at our last meeting, on the 25th of July, I told you that we thought we could make the manufacturing business pay a little. Since then we have been further strengthened in our views on that point, because we find that there is a very large business doing in the manufacture not only of the patented articles, such as transmitters and receivers, but in no end of articles in connection with telephonic exchanges, and that principally the business has gone into other hands, and we are at this moment striving to the utmost of our power to wrest that business from those companies, and get it into our own. If we cannot get it, it will go hard with us; but I think we can. We have machinery on our works which is not to be equalled in Europe—possibly it may be at Antwerp, but that is the only place where it is equalled. As soon as we get on our legs more firmly we mean also to go to the Continent and compete for business there. There is no reason why we should be restricted to England and to our own subsidiary companies. There is plenty of work to be done if we can only get hold of the business. The only thing that I can see that will prevent our making a profit out of this business of yours is litigation on various points. I think that is really the one thing that we have to fear. I have just roughly jotted down a few figures as to the amount of money we have paid out, and how we stand at present, to show you that the Company, at all events now, is in what you may call smooth water. According to the report of May last, I think it was—the annual report—on coming into power we found that we had to pay £3,500, and there was about £100 in the bank to do it with. That was not a very nice prospect to start with. There was certainly a sum of £3,150 due from various people, but on looking carefully through that we found it consisted of a great many consignments of goods abroad, which were not sold. I think I may say that there was about £200 that we could lay our hands on. As you are well aware, gentlemen, the Board proposed that to get rid of those liabilities, and to have some further working capital, some of you should purchase River Plate debentures and shares from us. Well, I am happy to say that the River Plate shareholders then came forward in a manner that I did not expect, and took something like £2,000 worth of shares. In all we received from the sale of debentures and shares about £9,000, and we also received from the River Plate Company interest and debenture interest to the amount of £1,200 and £500 in cash, and we discounted for the Edison-Gower-Bell two bills of £600 together; and, after a very hard fight for it, we received money from Australia which they were withholding from us. In round numbers that amounted to about £1,200. That was the amount of receipts. All the debts had been paid except the solicitors' bill, which we could not settle. We were in hopes that we could make a compromise with them, but we could not do it. The debts that we paid amounted to £2,700, leaving £800 for the solicitors unsettled. We provided money for Austria £4,500, and a further sum of £1,300 for the Edison-Gower-Bell. Income tax was reduced £100, making that £240, and we have spent about £100 on the machinery. That amounts in all to £8,840, which leaves a balance of £3,360. We have in the bank at the present moment £4,333, and we have perfectly good debts owing to us for instruments we have sent out quite lately to the amount of £5,200, making altogether £9,500, so that you may safely say that your Company is perfectly solvent now, at all events. I think that is not a bad statement to make after half a year's working. Now I will say a few words about the River Plate. Someone, I cannot tell you who, sent a newspaper round to

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all the shareholders of the Consolidated Company, and in it there was a statement—as if that were something very alarming—to the effect that there was an opposition company on the River Plate. I do not know with what object that was sent to the shareholders, or whether it was to frighten them or not, but it was sent. I thought naturally that the shareholders were aware that there was an opposition company on the River Plate. I am not aware that the late Board ever kept that fact in the dark; anyhow, there is the position. I should tell you, however, that Mr. John Taylor, who is the present chairman of the River Plate Board, and who has also been elected a director of this Board, has gone out to the River Plate, and with him sailed the chairman of the opposition company, and these two gentlemen have gone out there in the hope that we shall arrive at some satisfactory compromise, and the probability is, I think, that these two companies will be amalgamated. That will be a most satisfactory thing for you. That River Plate business is a very good one, I am sure of that, and the only doubt that we could possibly have was that we should fight and cut each other's throats. I believe if we could interpret aright the telegram that we have since received it means that the managing director from the other side of the water is now on his way to England with a proposal for amalgamation. I believe he is. Now, gentlemen, the Edison-Gower-Bell Company we at present have not got into our own hands. At this moment your Board has made proposals to the Edison-Gower-Bell Board, and I hope and trust that they will be accepted. If they are accepted I believe you will find they are very satisfactory for the Consolidated Company. I will say no more on that head. We are doing very well in Austria. The last report, which I received yesterday, from Mr. Kreuzer, stated that he had 810 telephones running, and in July last we had only about 605. I think that is a very satisfactory increase, and not only so but we have got plenty more people to work upon. I should further tell you that, seeing we have such a very large stake out in Austria, your Board have deemed it desirable to send one of its members out to Vienna, to personally inspect the property and see that we have got it. We think we have got it; but thinking is very different from being quite certain. That gentleman sailed last week. I have no doubt in my own mind that he will come back with a satisfactory report to us. We may, perhaps, send some notice to you of what that report may be. However, it is too far ahead to say anything about it. The next act of importance that we did in your interest was this, that our present manager having to go to New York on his own private business, we thought it a very good opportunity to open up negotiations with the great American Bell Telephone Company, so that we might, instead of fighting and squabbling, have friendly relations with them, the same as we have with the United Telephone Company. Now, gentlemen, I do not think that I have anything more to tell you, but if any gentlemen ask questions I shall be happy to answer them.

A SHAREHOLDER: What is the litigation that you referred to?

The CHAIRMAN: We have no litigation. The only little suit we have at the present moment is in Australia, which really is, I think, according to the latest advices, proceeding most satisfactorily. It appears our opponents out there are likely to compromise the matter with us, and pay the costs that we have incurred. In the telephone world, anybody who knows anything about it is well aware that litigation seems to be one of the chief factors of the business. It is an unfortunate thing for the shareholders, but a very good thing for the solicitors. We shall have no litigation with the United Telephone Company. The first resolution is, "For adopting the original and further reports of the committee of shareholders appointed on the 23rd May, 1884." That is a very simple matter, and I therefore propose that this resolution be adopted.

Mr. J. H. BUCKINGHAM said he had great pleasure in seconding the motion. Individually the shareholders must all feel that they were very much indebted to the committee for what they had done. He would not say which of the members had done the most of the work, but that collectively they had done it exceedingly well. He would add one word of advice to them, and that was to go on investigating their affairs, and when they felt they had got the right game in their hands to do what was necessary to secure it. He saw that the Directors had done him the great honour of putting his name on the Board of the Edison-Gower-Bell Company. He had not expected that compliment, but since they had been kind enough to confer it upon him he would say in return that if the Edison-Gower-Bell came into connection with the Consolidated, and if there was anything really to be got out of it, and if his services would be of any use they would be at their disposal. He thought that the committee ought to have recommended the reduction of the capital to one-fourth instead of the proposed figure, and strongly urged the Chairman to husband the Company's resources until they had thoroughly threshed out all the doubtful points now before them, and when that was done he hoped they would be able to spare something for dividends.

The CHAIRMAN said he endorsed every word Mr. Buckingham had said. The only exception he took was as to the amount of capital to be reduced. The question had been fairly considered by the committee, and they came to the conclusion that they might fairly value the assets of the Company at the amount stated in the report, which was about £170,000; though, as Chairman of the Company, he personally would have every reason to be satisfied if they were to knock down the capital to a fourth, inasmuch as it would enable him to recommend a larger dividend when the time came. They had now some money, he was glad to say, but they did not wish to spend it rashly.

The motion was then put to the meeting, and declared carried.

The CHAIRMAN next moved a resolution, "Authorising the payment out of the funds of the Company of the legal and other expenses incurred by the said committee," and, in reply to a shareholder, said that those expenses, as far as he knew, amounted to about £50.

Mr. GREEN seconded the motion, which was carried unanimously.

The CHAIRMAN: We now come to a very old story, and that is the adoption of the original report. It was a report, when I first saw it, that did not please me very much. I have very few remarks to make on it further than that of the sum in the revenue account of credit balance—£10,290—we think that £7,050 should not be taken as profit at all, for the very good reason that that was for the compromise of the telephone contract—and you must have paid a very much larger sum than that £7,050. Therefore we cannot see how it should be called a profit. We therefore propose that that should be taken as a sum which will in the future be written off against goodwill and patent rights, &c., which I think is a very prudent thing. The further profit, which will amount to about £3,200, we think might be used to write off certain items, such as depreciation of plant, bad debts, and one thing or another, as it seems that no reserves have been provided for depreciation of plant, machinery, goodwill, patents, &c. Therefore I propose our "Adopting the annual report and accounts dated the 14th May, 1884, subject to such readjustment as may be necessary in respect of the loss sustained by this Company by the compromise of the action brought in respect of the 4,000 telephones contract mentioned in the further report of the Committee."

Sir ALEXANDER ARMSTRONG, K.C.B., seconded the motion, which was unanimously agreed to.

Mr. J. H. BUCKINGHAM again paid a warm tribute to the members of the Committee of Investigation for their zealous services, and suggested that they should be rewarded with some honorarium. He thought that under the circumstances £200, to be divided as the members thought fit, would meet the necessities of the case.

Mr. PITT COBBETT seconded this proposal, and complimented the Committee on the lucid, succinct, and intelligible report which they had presented to the shareholders.

The motion was cordially agreed to.

The CHAIRMAN: It is said that virtue is its own reward, and undoubtedly your Committee of Investigation have the proud satisfaction of having been of service to you. At the same time I think they will be gratified by the substantial reward—I call it substantial, for we did not expect to get anything—which you have voted them; and in their names and in my own behalf I thank you for it most heartily. The next resolution is with respect to the appointment of a second auditor, the consideration of which was adjourned at the last meeting. We intend to leave this question entirely in the hands of the shareholders.

Mr. J. H. BUCKINGHAM proposed the appointment of Mr. Green, at a remuneration of £25, in addition to Messrs. Deloitte, Dever, Griffiths and Company, who receive £50.

The CHAIRMAN seconded the motion, which was agreed to.

The business of the ordinary meeting being thus concluded,

The SECRETARY read the notice convening an extraordinary meeting, after which

The CHAIRMAN said: Gentlemen, the first resolution we have to propose is concerning the serious matter of the reduction of capital. As you have read in the report that reduction appears absolutely necessary, and I do not think I need make any further remark on the subject. The resolution that I propose is:—"That the capital of the Company, which is now £300,000 (divided into 300,000 shares of £1 each, of which 224,850 are in issue and are fully paid), be reduced to £243,787 10s., divided into 224,850 shares of 15s. each, and 75,150 shares of £1 each, at present unissued, and that such reduction be effected by writing off from each of the said 224,850 shares the sum of 5s. per share as capital lost or unrepresented by available assets."

Mr. HENRY GREWING seconded the motion, which was carried *nem. con.*

The CHAIRMAN next moved:—"That the following alterations be made in the Articles of Association—that is to say, Article 51, for the words 'the nominal amount of the capital' substitute '£50,000.'"

Sir A. ARMSTRONG seconded the motion, which was agreed to.

The CHAIRMAN proposed that Article 87 should be altered so as to read as follows:—"Article 87. As remuneration for their services, the Directors shall be paid out of the Company's funds the sum of £1,500 per annum, and such remuneration shall be divided among them in such shares and proportions as they or the majority of them shall determine." Gentlemen, the original amount was £3,000 per annum and a sum equal to 20 per cent. of the net profits of the Company after the Directors had paid the shareholders 10 per cent. There is a feeling in the Board which has been expressed to me that, as we with our money, so to speak, subscribed largely to the £9,000, and as by our hard work we are apparently making this Company a success, you ought to increase our remuneration. £1,500 among nine gentlemen is not a very large sum, and I have stated to the Board that I would mention the subject, as they feel strongly on the point. However, what we have to pass now is the alteration of Article 87 as I have read it.

Mr. BUCKINGHAM seconded the motion, which was agreed to.

The CHAIRMAN afterwards moved "That to Article 89 shall be added the following clause:—'If he hold or accept any other place of profit or office under the Company, with the exception of Managing Director."

Major HENRY T. G. FITZ-GERALD seconded the motion, which was carried.

The CHAIRMAN: The next resolution I propose is "That Article 90 shall be struck out, and the following Article substituted therefor:—'Article 90. No Director shall contract or be personally interested in any contract with the Company; but no contract or arrangement entered into by or on behalf of the Company with any company or corporation of which any Director shall be a member or officer shall be avoided, nor shall any Director being such member or officer be liable to account to the Company for any profit realised by any such contract or arrangement by reason only of such Director holding that office, or of the fiduciary relation thereby established, and such Director may vote in respect of any such contract or arrangement.'"

Mr. A. H. BAKER seconded the resolution, and it was also agreed to.

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The CHAIRMAN finally moved that "Article 112 should be struck out," which was seconded by Mr. BAKER, and carried.

A vote of thanks was accorded to Mr. Fitz-Gerald for presiding, and the proceedings terminated.

Swan United Electric Light Company (Limited).

The adjourned meeting of this Company was held on Tuesday at the Guildhall Tavern, Gresham-street, E.C., for the purpose of considering the re-election of Directors, or the appointment of others in their places.

Mr. JAMES STAATS FORBES presided, and said: In conformity with the determination of the proprietors at the last meeting we stood adjourned for a week. Proper notice was sent out, which I dare say every proprietor has had, stating that to-day we should reassemble for the purpose of considering the re-election of Directors. I dare say the proprietors who were present will remember exactly how it stands. A wish was expressed on the part of considerable proprietors present that they should have the opportunity of suggesting—not the re-election of retiring Directors, but the introduction of what is usually called new blood. Well, we felt on this side of the table that that was a rational request, and at the end of some discussion it was determined the meeting should be adjourned for a week that the leading proprietors might meet and might come here prepared to propose either at their discretion the re-election of the retiring Directors or such names as they considered would fairly represent the leading proprietors, or a considerable section of proprietors, and would be useful to the Company in strengthening the Board, and give greater confidence to the general body of shareholders. That being the business of the meeting, I shall be very glad to hear what the representatives of the leading proprietors have to say.

Mr. SWAN: Mr. Chairman and Gentlemen—I do not think that my position as a director disqualifies me from suggesting a course of action at this meeting. What I rise to propose is, that the meeting should re-elect the three gentlemen who retire by rotation—Major-General Trevor, Mr. J. C. Stevenson, and Mr. Villiers. In recommending this course of action I feel that I may as well use an argument which was used at the last meeting by the Chairman, that "it was not well to swap horses while crossing a stream." But, in addition to that I must add this, that I conceive that the business of our Company—in which I am as deeply interested as any of you, probably more so, for I not only have a pecuniary interest, but an intensely important moral interest—has suffered very greatly from the circumstance, a perfectly inevitable circumstance, that at the outset there were no persons who were acquainted with the business. We had to start the management of the Company by means of Directors who, from the necessity of the case, did not understand the kind of work which had to be done. I believe that the slow progress that the Company has made, and mistakes if you like also, have arisen entirely from the inexperience of the Directors, the inevitable inexperience, because at the time there were not Directors to be had who were acquainted with the business of electric lighting. I think if we now choose other Directors who have not had an apprenticeship to the business, we should be sacrificing the very valuable experience which has been obtained on this Board, and which is certainly calculated to promote the success of this Company. In addition to that you could not find three men who have all the other qualifications which the three retiring Directors possess—I mean the qualifications of general competence and assiduous attention to the details of the business. Mr. Stevenson is quite exceptional in his having a longer experience in electric lighting than probably any other commercial man in England. He was the chairman of the first formed incandescent electric lighting company in England. For these reasons, gentlemen, I propose the re-election of the three retiring directors.

General TREVOR seconded the motion. He thanked Mr. Swan for having proposed his re-election, but he should be glad to be relieved of his duties, and had only remained a Director because he was reluctant to abandon the Company while it was in trouble. He would like to say a few words with regard to their foreign business. On account of the fire that had occurred at Lille the report and accounts presented did not give an accurate statement of their prospects. They were aware that they gave Mr. Swan £110,000 for their foreign patents; in the two years and three months the Company had been in existence that had only been increased by about £3,000. When they took over their foreign business the manufacture of lamps was on a satisfactory scale, and the quality of those lamps was good, but unfortunately the sales were not very large. They had to meet severe competition abroad and had to compete with companies in carrying out installations and exhibitions at less than prime cost. Their customers were threatened with legal proceedings if they used their lamps, and one of their opponents went so far as to partially seize one of their factories. They contented themselves with telling their customers that they would bear them harmless in case of their being attacked; but later on they took the initiative and instituted suits against certain parties, and since then their business had prospered fairly well. The sales abroad had more than doubled, and during the last quarter, but for the unfortunate destruction of the factory, the earnings abroad would have equalled about 7 per cent. on the amount of the capital employed in their foreign business. They paid at Lille about £650 for salaries and wages to workmen, and in return they did not get one single lamp; besides that they brought from the Newcastle factory a large quantity of lamps, and the difference between that and what they could have made them for at Lille amounted to another £1,250. Further than that, if the supply had been sufficient they might have had orders for a large quantity of lamps on which the profit would have amounted to £900. That came to about £2,800, and if they deducted from that the £400 shown as loss the difference was £2,400, which would have stood to their credit on the quarter's business, but for the unfortunate loss at Lille, and that £2,400 came to about 7 per cent. on their capital. As regarded the future prospects of the business his impression was that even if the business did not expand, if they maintained the quality of their lamps at their present standard, they might safely look forward before very long to a very fair return on their foreign investment. As regarded the English business, he did not feel himself called upon to say very much. The losses in connection with installations had not been incurred by the present Swan Board; he believed that they had not undertaken a single piece of business on which they had not made more or less profit. The only thing on which they had lost money and in which they did make a mistake was in connection with taking out provisional orders; but they thought the *raison d'être* of their Company was to carry out lighting by rentals, in the same way as the gas companies supplied gas. When London was parcelled out into divisions they took four of the best, and they had a struggle to get them. This cost them money, and by the time they got the orders and began to realise their position there had been a great fall in electric lighting shares, and they did not think their shareholders would like to be embarrassed in further enterprise, and they did not proceed. All they had done was to obtain from the London, Chatham, and Dover Railway power to light their station at Victoria, thus giving them a central lighting station for the Victoria district. It was their object to obtain that, and not to light the Chatham and Dover itself. As far as the installation was concerned, it was finished and working very successfully, and would cover expenses. They had a building large enough to light the whole district, and the machinery was sufficient to supply the whole of the stations and the buildings round about. He was now going to leave their Board, and he left it with the firm conviction that the worst stages of the Company were over, and that they had before them, though not an unclouded, a brilliant future.

Mr. DOBREE said he had an amendment to propose, but he did not move it from personal feelings. He had no doubt that the three retiring Directors had honestly done their best to successfully manage the affairs of this Company; but he represented a number of large shareholders who were not satisfied that their efforts had been crowned with success, and they were determined to have fresh blood on the Board. At the last meeting he represented nearly 40,000 shares, so that he thought that they were entitled to have some voice in the management of the concern. He moved that Mr. W. C. Quilter and Mr. Frederick R. Leyland be elected Directors of this Company, and that the third vacancy be not filled up.

Mr. VERITY seconded the amendment.

Mr. BALFOUR thought it would be the best thing for all parties to allow the three gentlemen to retire. He thought the shareholders owed a debt of gratitude to those who had come forward to take their places.

Mr. VILLIERS said that he should have great pleasure in retiring in favour of the two gentlemen proposed. The present Board had not been able during the past history of the Swan Company to bring it to the state of prosperity which they had hoped for, but he believed that it had been from no fault of their own.

Mr. STEVENSON, M.P., agreed with what General Trevor had said. The shareholders had it entirely in their power to make a change in the directorate if they chose to do so, and he had no complaint to make. He believed that the Company had seen its worst, and that it was on the road to a success in spite of all the difficulties it had encountered and might have still to encounter. He had not the slightest ambition to continue a Director if they wished otherwise. He should be glad to find that the new Board had been able to do what he had been trying to effect for a long time, viz., succeed in distributing the shares amongst the shareholders. He hoped that a change in the Board would not have any injurious effect on the litigation in several countries in Europe. He might say that since the Directors took courage to face their opponents on the Continent they had done a larger business than they did before. He might say that in Mr. Stearn, the Managing Director, they had a man in the highest degree qualified to do the work, and he hoped that that gentleman would have the loyal support and confidence of any new Board that might be appointed. Mr. Stearn had a large personal interest in the concern, and had been associated with the Swan Company from the beginning, and if he were supported he had no fear for the future prospects of the Company. He did not say that the Company would suffer from the change, but he knew that his two colleagues had rendered most active service to the Company.

Mr. KEMPSTER was exceedingly sorry that he was unable to support the very happy family arrangement which seemed to have been made. He thought it would be a most ungrateful and inexpedient thing to turn out the three retiring Directors, who he believed had done more active service than any of the others. They were turning out gentlemen who had given practical and conscientious attention to the business of this Company. There was a certain ring of large proprietors who were determined to get the matter into their own hands. He said that that might answer for the time, but not for long. It was a high-handed proceeding that would defeat itself in the end, and he was sorry that gentlemen of position and repute should have lent themselves to such an arrangement. Mr. Stevenson spoke out a little plainly at the last meeting, and it was evident that no one must speak plainly as to the proceedings of this Company if he wished to remain on the Board. Why should they not re-elect the retiring Directors and add two more to the Board? Continuous blunders had been made in this Company, but he believed that the course proposed would prove to be the greatest blunder of all.

Mr. FOSTER said that he had read the report of the proceedings at the meeting of the shareholders in the United Company, held on the 11th November, and there he observed the name of the gentleman who had just spoken. Mr. Kempster had been the cause of dissension in at least one company with which he (Mr. Foster) was connected, and when he saw

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that he was taking an active part in this Company, he determined to attend the meeting, in order to counsel the shareholders not to be guided by his advice.

A SHAREHOLDER thought that Mr. Foster should not air his grievances in another company at this meeting.

Mr. FOSTER continued that he had no personal grievances, but knowing how another company had suffered he had mentioned this. He was prepared to justify what he had said, and had attended to warn the shareholders not to allow Mr. Kempster to have any hand in the management of this Company.

The CHAIRMAN: I am sure the proprietors will appreciate the motives of the gentleman who spoke last, because he desires to warn them against some other gentleman who, although he has a very few shares—I think only five—has a strong feeling and has said a great many hard words of the Directors. When you find a man proclaims that other people are very dishonest, and that he is the only honest man, all I can tell you is to look up your pockets [laughter]. The offence apparently is that the proprietors of this concern, who have a substantial stake in it, think fit to govern it themselves. Well, thank God! in companies at all events we have not yet come to manhood suffrage, where declamation, want of knowledge, and good hardihood of statement carry away a lot of unthinking people. The shareholders of this Company are men of intelligence and position, and they can judge the real value of the balderdash which Mr. Kempster has indulged in, and they will take no notice of it, but simply proceed with the business which this meeting was called to finish, because we had enough discussion at the last meeting on these general topics. I felt at the last meeting that the chairman was more or less responsible; at all events he is the figure that is to be fired at at meetings. I do not care who fires at me. I think I can take care of myself; but I did advise you then to select the Directors. I have been loyal to my colleagues, and I think if the Company had been prosperous we should not have heard a word raised as to the new blood. It is the usual thing. Men must accept jobs of this sort upon the usual conditions; if they succeed, all right; if they fail, well, they must be kicked out. I am quite open to it—I accept the position with that alternative; but in the face of the strong expression of opinion that this Company does want other men, I am not going to say a word against the amendment, and it is my business to put the amendment. But the amendment needs a slight modification in order to meet the necessary legal requirement. It will have to take this form:—"That the number of Directors be reduced from eight to seven, and that Mr. W. Cuthbertson Quilter and Mr. Frederick R. Leyland be and they are hereby elected Directors of the Company." The Articles of Association require this:—"If at any meeting at which the election of Directors ought to take place the places of the vacating Directors are not filled up, the vacating Directors, or such as have not had their places filled up, shall continue in office until the ordinary meeting in next year, and so on from time to time until their places are filled up." So that if you only elect two and three retire, you leave one not filled up, and then we should have the exceedingly invidious duty at the Board of considering who is to remain, and we should defeat the object of the proprietors that they should have time for consideration and consultation as to a further name. Therefore I put the amendment in that form.

The amendment as altered was then put to the meeting and carried.

A vote of thanks to the Chairman terminated the proceedings.

The Anglo-American Brush Electric Light Corporation.

The report of the Directors of this Corporation is as follows:—

The Directors have convened an extraordinary meeting of the Corporation to consider, and, if deemed advisable, to pass a resolution ratifying the provisional agreements entered into with the Great Western Electric Light and Power Company, and the Brush Midland Electric Light and Power Company, providing for the absorption of these companies by the Corporation, and to authorise an increase of capital to an amount dependent upon the number of fully paid shares in these companies surrendered to the Corporation; such increase, however, not to exceed in the aggregate 6,695 fully paid £5 shares in the capital of the Corporation. These are the only two British companies (with the exception of two local companies possessing sub-licenses for two towns on the south coast), which hold concessions precluding the Corporation from doing general business in the districts assigned to them, arrangements having been made with the other subsidiary companies in England (viz.: The Hammond Company, the South Eastern Brush Company, and the Provincial Brush Company) by which the Corporation are enabled to supply both incandescent and arc apparatus in their districts. As the shareholders were informed in the last annual report, the Corporation have found it advisable to take up the position of contractors, and not confine their operations as formerly merely to the manufacture of electrical apparatus; and this being the case it is desirable that practically the only limitations to the power of the Corporation to undertake work in any part of the United Kingdom should be removed by the absorption of the Great Western and Midland Companies. It is proposed to take over the business of these Companies as going concerns, thus securing to the Corporation their present local organisations, which it is believed are capable of further considerable development. The terms of purchase are in the case of the Great Western Company that the Corporation shall issue shares in the proportion of three £5 fully paid shares for every twenty £2 10s. shares, the shareholders in the Great Western Company receiving in addition out of the available funds of that company ten shillings per share in cash. In the case of the Midland Company, the terms are that the Corporation shall issue shares in the proportion of four fully paid £5 shares for every twenty-seven £2 10s. shares. The negotiations which have resulted in the above-mentioned provisional agreements have been most carefully and considerately carried out, and the Directors feel that they are justified in recommending these terms to the shareholders as fair and equitable, and at the same time as not without material advantage to the Corporation, as enabling them more effectually to carry out a policy in the future which past experience shows to be desirable. The arrangements if adopted will involve a maximum increase in the share capital of £33,475, of which £19,362 will be distributed to the shareholder in the Great Western Company and £14,113 to the shareholders in the Midland Company. For this increase of capital the Corporation will obtain not only a return of the licenses for 28 counties in England and Wales granted to these companies, but also the benefit of the operations of these companies during the past two years, from which well organised and established business may be expected to result. The Corporation will further receive good tangible assets, including cash, plant, land, buildings, &c., amounting in the aggregate, after deducting all estimated liabilities and expenses, to about £28,500, of which £4,100 consist of calls in arrear. If these calls are all paid the consideration which the Corporation will have given for the licenses and goodwill may be estimated as not exceeding about £5,000 in shares. The meeting is called in accordance with the Articles of Association for the consideration of this special business only, and as the ordinary general meeting will shortly be held, at which the accounts of the Corporation, made up to the 31st December, will be submitted, the Directors defer their report upon the general business of the Corporation and other matters.

The resolution to be proposed is as follows:—"That the provisional agreements entered into beween the Corporation and the Great Western Electric Light and Power Company (Limited) and the Brush Midland Electric Light and Power Company (Limited and Reduced), dated respectively 28th November, 1884, and 29th November, 1884, and submitted to the meeting, be and the same are hereby sanctioned, adopted, and confirmed; and that the Directors be authorised to carry the same into effect respectively with or without modifications, and for that purpose to enter into and execute all necessary deeds and documents, and to issue not exceeding 6,695 fully paid £5 shares in the capital of the Corporation, such shares to be numbered from 40,701."

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. DEC. 17.		BUSINESS DONE WEEK ENDING DEC. 17. Highest.		Lowest.
Anglo-American	34½,	35½	35½		34¾
Do. Preferred	58½,	59½	59¾		58⅝
Do. Deferred	9,	10	10⅛		9½
Brazilian Submarine	11⅛,	11⅜	11⅜		11 3-16
Cuba	11,	11½	—		—
Do. Preference	17,	18	—		—
Direct Spanish	3½,	4	—		—
Do. Preference	14½,	15½	—		—
Direct United States Cable	10,	10¼	10⅜		10¼
Eastern Telegraph	11⅞,	12	12		11¾
Do. 6 per Cent. Preference	13⅝,	13¾	13¾		—
Do. 5 per Cent. Debentures, 1899	104,	107	—		—
Eastern Extension	12½,	12½	12½		12½
German Union	9¼,	10¼	10¼		—
Globe Telegraph and Trust	7⅛,	7⅝	7⅝		7⅝
Do. Preference	12⅝,	12¾	12¾		12¾
Great Northern	14⅛,	14¾	14¾		14⅝
Indo-European	32,	33	32½		—
Reuter's	7½,	7¾	7½		7¾
Submarine	175,	180	—		—
West India and Panama	¾,	1	—		—
Do. 1st Preference	7½,	7¾	—		—
Western Brazilian	6½,	7	7		6¾
Western Union 7 per Cent. 1st Mortgage	120,	125	121		—
Do. 6 per Cent. Sterling Bonds	100,	103	—		—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	9-16		7-16
Oriental	⅛,	⅜	3-16		—
United Telephone	11⅞,	12¼	12 7-16		12

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1½,	1¾	—		—
Do. (fully paid)	3½,	3¾	—		—
Hammond Light (£3 15s. paid)	⅝,	¾	13-16		11-16
Swan	⅜,	⅝	½		—
Maxim-Weston	⅛,	¼	3-16		—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35½		34¾
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	23		—

TRAFFIC RECEIPTS FOR NOVEMBER, 1884.

COMPANIES.	Nov., 1884.	Nov., 1883.	Increase.	Decrease.
Direct Spanish Telegraph	1,736	1,781	—	45
Eastern Extension	42,286	36,719	5,567	—
Eastern Telegraph	55,640	49,390	6,250	—
Great Northern	22,800	—	—	—
West Coast of America	4,015	—	—	—

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NOTES.

BRAZILIAN SUBMARINE CABLE.—The cable of this company which was broken by a ship anchor half a mile from shore has been repaired.—The traffic receipts of this company for the week ended 19th Dec. amounted to £3,486.

VOLK'S ELECTRIC RAILWAY.—The Servian Commission, comprising the Servian Minister, the Mayor of Belgrade, &c., paid a visit to Volk's Electric Railway, Brighton, and inspected everything, expressing themselves much pleased with their visit.

EARTHQUAKES AND THE BAROMETER.—At the meeting on 8th inst. of the Paris Academy, M. F. Laur called attention to the coincidence of an earthquake felt at Saint-Etienne, in the centre of France, and a rapid fall of the barometer preceded by a continuance of high readings.

ELECTRIC LIGHT IN CHELSEA.—At a recent meeting of the Chelsea Vestry, a proposition was carried that the Electric Lighting Committee and the surveyor be instructed to confer with the solicitor of the Chelsea Electricity Supply Company as to the provisional order of the company.

THE TELEPHONE AT FULHAM.—At a recent meeting of the Fulham District Board of Works, the assistant clerk presented a contract with the United Telephone Company for fitting up telephone apparatus complete, on the exchange system, at a yearly rental of £20. The matter was referred to the Works Committee.

LONG-DISTANCE TELEPHONY.—M. Van Rysselberghe's experiments in simultaneous telephony and telegraphy over the line between Lisbon and Oporto, 312 kilometres = 193 miles, are reported to have been perfectly successful, while it is proposed to apply the Van Rysselberghe system to all the Portuguese telegraph lines.

LIGHTING AT ST. GEORGE'S, HANOVER-SQ.—The Electric Lighting Committee has reported that it had informed the Board of Trade that, so far as that parish was concerned, the vestry was willing that the West London Electric Lighting Company should have the extension of time they asked for securing the deposit required under the terms of their order.

RAILWAY CARRIAGES WARMED BY ELECTRICITY.—Some experiments in this direction have been going on lately at the works of M. Meritens, in the Rue Boursault, Paris. Current is generated by a Gramme machine, and produces heat in boxes externally resembling the present foot-warmers, where it is evenly distributed by a special appliance and radiated into the carriage.

ELECTRIC LIGHTING AND THE BOARD OF TRADE.—At a recent meeting of the Lambeth Vestry, a letter was received from the Board agreeing to certain modifications in the draft scheme prepared under the Electric Lighting Act, and stating that the Board would not require an undertaking to execute any specific works in any specified time, and also giving the Vestry permission to enter into sub-contracts.

LENGTH OF SUBMARINE CABLES.—*Kosmos* puts the total length of all the submarine cables at present laid at 60,000 geographical miles, about 111,000 kilometres = 68,352 miles, or nearly three times the circumference of the globe. Each cable consists on an average of 40 wires, so that the total length of iron and copper wire used amounts to twenty-five millions of miles, or ten times the distance between the earth and moon.

THE CABLE FLEET.—The ss. "Chiltern," belonging to the Eastern Telegraph Company, is now being fitted up with a view to work in a tropical climate, it being intended that this vessel shall relieve the "Great Northern" on the Zanzibar Station. The vessel is to be fitted with the electric light. The ss. "Magneta," whose launch we recorded last week, and which we intend to illustrate next week, will, as soon as ready, relieve the "Agnes" at Singapore.

ELECTRICAL TECHNICAL DICTIONARY.—A correspondent has stated that he would find very useful a complete index to *The Electrician* from its commencement; now we will state a want we have experienced, and which is no doubt also felt by many of our readers. This is a dictionary of electrical terms and those used in telegraphy, with concise definitions, and their French and German equivalents. Here is a field open for the enterprising firm of Spon, London and New York.

ELECTROLYSIS OF SOLID GLASS.—On this subject, E. Warburg comes to the conclusion that the anion SiO_3 remains practically in place; the sodium alone appears to be displaced, that of the anode entering little by little into the glass, while an equivalent quantity of glass penetrates the cathode. The re-formation of the silicate in the anode would therefore be intimately connected with the displacement of the sodium, that is to say with the passage of the current, and would not constitute a secondary phenomenon.

NORMAL MAGNETISM OF ELECTRO-MAGNETS.—P. Bakmetieff's experiments show that, in the case of electro-magnets not closed, the measure of the normal magnetism is the arithmetical mean of the intensities, C and c, of two induced currents, obtained by closing the direct and inverse magnetising circuit, that is to say $\frac{C+c}{2}$. For a closed circular electro-magnet, the measure of the normal magnetism is $\frac{2C+c}{2}$.

WEST INDIES.—Port of Spain is jubilant at the prospect of a telephone exchange. The *New Era* says it will no doubt be a welcome piece of news to the numerous subscribers who are pledged to support the new undertaking prompted by Mr. A. W. Gray to learn that the movement is now placed beyond the pale of mere speculation. Mr. Gray was expected to arrive from New York with all the necessary supplies for commencing proceedings, and it was fully expected that the new system, with its many exceptional advantages, would be in operation in the early part of January next.

"L'ELECTRICIEN."—Next year our Paris contemporary will appear weekly instead of fortnightly, as at present. "The principal object of *L'Electricien* is to place at the disposal of all engaged in this science an organ perfectly independent and free from any commercial or financial influence." More space will be devoted to practical applications, without neglecting questions of pure science. We so frequently find occasion to borrow from our contemporary that we offer our congratulations on the necessity which arises for what is practically an enlargement.

LIGHTING BY CHROMOZONE BATTERIES.—Mr. Charles Penruddocke, of Compton Park, has his drawing room brilliantly lighted by incandescent lamps, maintained by chromozone batteries. He has also fitted incandescent lamps to the pulpit and reading desk at Compton Chamberlaine Church, so that the clergyman can switch on the light at any moment he pleases. Mr. Penruddocke states that the expense is very moderate, considering the difference in brilliancy between the electric light and gas; and the steadiness of the light is remarkable. The batteries are said to be cheap, simple, and easy to maintain, and not to require changing more than once a week.

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HELL-GATE LIGHT, N.Y.—This powerful light, the inauguration of which on 20th October last we duly noted, surmounts a lattice tower 250ft. high, so that, though thoroughly lighting up the roads, it does not dazzle the eyes of navigators. About 6ft. below the top of the tower is a gallery, with a slight framework above, carrying the nine lamps, which light up three-fourths of the circle. A grooved pulley and steel rope, with guided tub and counter-weight, serve for the man that attends to the lamps to draw himself up and let himself down by. The illuminating power of the nine lamps is equal to that of 54,000 candles, the current being supplied by a No. 8 Brush dynamo.

OVERHEAD WIRES.—At a recent meeting of the Marylebone vestry Mr. Endean observed that the Master of the Rolls and Mr. Justice Lindley had confirmed a previous decision in law that a telephone company was liable to pay rates to the Corporation of Manchester for overhead wires.—At a meeting of the Clerkenwell Vestry, a communication was received from the Vestry of St. George's, Hanover-square, transmitting copy of a letter they have addressed to the Local Government Board, urging it to bring the erection and maintenance of overhead wires under some adequate local authority. A resolution was adopted, concurring with the views of the St. George's Vestry.

INFLUENCE OF ELECTRICITY ON STEAM.—In a short paper on the "Influence of the electrical condition of a liquid surface on the maximum pressure of its steam in contact with the surface," in the *Journal de Physique*, M. Blondlot comes to the conclusion that "when a liquid surface is electrified, if μ represent the electric density at its surface, the maximum pressure of the steam in contact therewith is less than it would be if the surface were not charged with electricity, the temperature being the same, by the quantity $2\pi\mu^2\frac{\delta}{\Delta}, \frac{\delta}{\Delta}$, designating the ratio of the densities of the steam and of the liquid.

MAGNETIC MOMENT OF WIRES.—With the view of ascertaining the difference of magnetic moment in a solid cylinder and a bundle of wires, P. Bakmetieff filled a hollow cylinder, 148mm. long and 32mm. inside diameter, with iron wires of 1, 2, and 5mm. diameter, and magnetised them by more or less intense currents. The magnetic moment of the finest wires, as well as its specific magnetism considerably exceeded those of the two others, especially in the case of intense magnetising currents. But when, instead of filling all the free space of the cylinder, he only inserted an annular layer of iron wires, the specific magnetism of the fine wires became, from the same current, many times greater than that of the thicker wires.

BISHOP AUCKLAND.—Messrs. Duff and Rowntree are holding their annual sale of novelties for Christmas. In addition to the usual lighting by "Swan" lamps inside and arc lamps outside the establishment, they have this year added a novelty in the shape of a large Christmas tree illuminated by Swan lamps, and a powerful "Bernstein" electric lamp opposite each window, attached to movable brass pendants. This firm has been exceedingly energetic in utilising the electric light for business purposes. The "Swan" lamps in the shops and show rooms are supplied from an Elphinstone-Vincent dynamo, the Weston arc lamp from a small Siemens dynamo, and the "Bernstein" lamps from a shunt "Siemens" dynamo, all on separate circuits—an arrangement that is found to answer admirably.

ELECTRICAL VERIFICATION OF DEATH—With reference to this subject, noted in our last, M. Bochefontaine concludes that it would be imprudent to found a method of distinguishing between real and apparent death on electro-thermic phenomena. At the meeting of the Académie des Sciences, Paris, on 8th Dec., he recalled the experiments made by him in 1878 on the diffusion of electric currents in the tissues of animals, and then posed the following question:—When an animal is subjected to the influence of a Faradaic current, in a limited space, under what conditions does contact by the the fingers with another portion of the body cause a shock to the experimenter? He reminded the members that experiments made successively on living and dead animals have given variable results, even with the same current and during the same experiment.

ELECTRIC LIGHT V. DYNAMITE.—Seeing how thoroughly the waterway under Charing-cross Bridge is lighted up by the five Crompton 3,000 candle lamps fixed on the up-stream parapet, it occurs to us that, if the electric light had not been suppressed on London Bridge, there would have been great difficulty in attaching the dynamite to the pier. Might it not be worth while, in the present state of affairs, to install a few arc lamps on all the London bridges and public buildings generally? There is plenty of power running to waste, both in the stream and in the flux and reflux; and we commend to the attention of engineers as a holiday task during the ensuing Christmas the problem of studying how that power may best be practically applied to electric lighting. In this connection we may recall the fact of a high authority stating that each electric light in large American cities was as good as a policeman.

INTENSE CURRENTS.—The committee appointed by the French Government to settle the conditions to be observed in laying the conductors for high-tension currents, have to consider the following points:—1. The precautions to be taken in laying wires underground, in sewers, and above or along buildings, for being introduced and installed in interiors. 2. A set of rules to be followed by contractors charged with laying conductors of current for lighting purposes or for the transmission of power. 3. What wires, cables, and insulators it is preferable to supply for such work. 4. The resistance opposed to the passage of electric currents by wires of different diameter. 5. The maximum intensity of current that may be transmitted by these conductors. 6. The best instruments for measuring the electromotive force of the current transmitted, and a certain method for checking them. 7. The precautions to be taken for keeping workmen free from danger.

ELECTRO-MAGNETIC SEPARATION OF IRON FROM ZINC ORE.—The mining engineers of Friedric hssegen, near Oberlohustein, in Germany, have been successful in separating iron from zinc in a blende conglomerate. After a preliminary and inexpensive roasting, which renders the iron magnetic, the ore is crushed into small pieces and thrown into a hollow revolving cylinder, inside which radiating electro-magnets are arranged. The magnetic iron is attracted by the magnets and adheres to them, while the blende falls through one end into the pit. To completely separate the two ores, it suffices to repeat this operation in the same or another cylinder following on after the first. Only a quarter horse-power is required for driving the dynamos that excite the magnets, and for rotating the cylinders. Eight of these appliances treat 48 tons of ore in 12 hours, separating 7 tons of blende containing 30 per cent. of

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zinc and, 18 tons of iron ore containing 38 per cent. of iron and 10 per cent of manganese.

E.M.F. VARIABLE WITH TEMPERATURE.—Helmholtz has demonstrated analytically, and Czapski has verified experimentally, the following fact, recently brought before the Paris Academy by M. Lippmann:—Certain galvanic elements have an electromotive force variable with the temperature, and also this remarkable property, that the energy which they manifest in the form of current is not equal to the energy of the chemical action measured by the calorimeter. The difference between the two quantities is due to the fact that the heat borrowed from the surrounding atmosphere is added to the chemical heat, to be transformed at the same time into electric or mechanical energy. M. Lippmann, in seeking what battery elements have an electromotive force variable with the temperature, has found that those are constant which satisfy the law of Kopp and Woestyne. Connecting this fact with M. Berthelot's former discovery, he arrives at the conclusion that, if the law of calorific capacities be verified, the chemical heat and electromotive force are equal, and also independent of the temperature. In the contrary case, the values of these properties become unequal and variable with the temperature.

TELEGRAPHING WITH DYNAMOS.—C. and E. Fein, of Stuttgart, have undertaken a series of trials with one of their 1 C double-current dynamos, as regards the application to telegraphy of this machine worked by hand, but with the intercalation of artificial resistances. The results of these trials, in which the dynamo was driven, not by hand but by a motor, which its strong construction permits, are given in the following table:—

Machine.			Morse	Instrument.
Revolutions per min.	Resist. Ohm.	Current. Amp.	Resist. Ohm.	E.M.F. Volt.
2,000	3·5	3	5,000	35
2,480	3·5	3·5	6,000	45
2,990	3·5	4·5	7,000	52
2,100	2	5	6,000	44
2,500	2	6·5	7,000	51
3,010	2	7·8	8,000	60
2,020	1	8	8,000	57
2,475	1	10	9,000	65
3,060	1	11·7	10,000	72

The Morse instrument, the electro-magnet of which had a resistance of 120 ohms, worked perfectly well under the above-named conditions.

AUSTRALIA.—A despatch has been received by the Governor from the Secretary of State for the Colonies on the subject of the resolution adopted by the Australasian Postal Conference last year respecting the proposed reduction of the charge for telegrams sent by the telegraph lines connecting Madras and Bombay with New South Wales. Accompanying the despatch is a copy of a letter upon the subject from the India Office, and according to this letter there is no disinclination on the part of the Government of India to meet the wishes of the Australasian Postal Conference for a reduction in the rates charged for Press messages on the Indian lines. So far as the Secretary of State for India is aware no objection has been raised to such a reduction by the telegraph companies interested in the matter; but it appears that Germany, as one of the administrations interested in the telegraph route to India, objects to any considerable reduction being made in the rates charged. A meeting of authorities representing the several telegraph administrations is, however, arranged to take place at Berlin in May, 1885, when the subject is to be discussed. Pending the meeting of this Conference, it appears that Lord Kimberley has no desire to raise any discussion on the subject.

EXCEPTIONAL PROPERTIES OF INDIA RUBBER.—In a note to the Russian Physico-Chemical Society, on this subject, N. Hesehus states that, in 1867, M. Govi proposed the following simple hypothesis for explaining the contraction of stretched india rubber by the effect of heat. The microscope shows that this substance is full of spherical pores filled with gas. When india rubber is stretched, these pores become elongated; if it be heated, the gas contained in them expands more than the substance, has a tendency to render the form of the cavities ellipsoidal, and thus causes the india rubber to contract. This theory has been subjected to various criticisms, notwithstanding its simplicity, and the author set about solving the question. In the above hypothesis the gas should exert its action through the variation of its expansion with reference to the pressure of the molecular forces and of the surrounding atmosphere. If the india rubber, stretched by a weight, be placed under the receiver of an air-pump, and a vacuum formed, it might be supposed that the length of the india rubber would diminish. Practical experience, however, does not confirm this supposition, as the length of the india rubber does not alter in a manner appreciable by the cathetometer, not even during a sudden readmission of air.

CAB, FIRE, AND POLICE CALLS.—With regard to our note on this subject last week, it may be well to state that some time since the Exchange Telephone Company made a sustained and strenuous attempt to introduce some such system. A complete circuit was put up at Holloway, but so little was the work appreciated that we believe not a single subscriber was obtained. The use of such a system in America is often cited as a reason why it should be in common use here; but it must be remembered that in America the call system is supplemented by a messenger system, a charge being made for the messenger. From this charge an income is derived—not from the call system of itself. In England—that is in London—the messenger system, tried and even now in existence under the auspices of the Exchange Company, has proved so unattractive that the charges for messengers alone would not pay. It so happens that other work can be done by the messenger staff, otherwise its existence would have been threatened long ago. Surely facts like these ought to cause men who speak or write for the public to consider whether it necessarily follows that because one system succeeds in one place it will succeed in another. It may be that the existence of this messenger system is insufficient enough, and we have taken this opportunity of again calling attention to it.

ENGINES FOR ELECTRIC LIGHT.—In reply to a letter asking what class of engine is best for driving electric light machinery, Mr. Powis Bale writes to the *Timber Trades Journal* that he most decidedly recommends the compound, "as it combines extreme economy in working with that regularity and exactness in motion which are necessary for effective electric lighting. The economy in working is secured in the first instance by using the steam at a high working pressure, say, 120lb. per square inch, and expanding it down to as low a point as possible before leaving the low-pressure cylinder, say to five or six times its original volume." He does not recommend a governor controlling the engine by means of the ordinary throttle-valve, as it "wire-draws" the steam. The governor should be furnished with heavy balls, and made very sensitive. A 12 horse-power compound engine, with loco-boiler, with a load of 30·26 horse-power on the brake, ran for three hours 45½ minutes with only 300lb. of Welsh coal, equivalent to a consumption

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of 2·63lb. per effective horse-power per hour, or about 2·41b. per indicated horse-power, while the feed-water required was only 20·461b. per effective horse-power per hour. Mr. Bale adds that he once attempted to light a large hall in the east of London by means of an ordinary engine, but that it was found necessary to substitute a compound on account of the unsatisfactory results.

THE "GREAT EASTERN."—In the case of Lawless *v.* Pyne a motion was made last week before Mr. Justice Kay, by Mr. Northmore Lawrence, on behalf of the plaintiff, for an injunction to restrain the defendants from allowing the "Great Eastern," which is now at Milford Haven, from proceeding to New Orleans under a charter party to the defendant. The defendant is the American agent of the World's Industrial Cotton Centennial Exposition to be held at New Orleans. The plaintiff had thought of chartering the "Great Eastern" for the Exhibition at New Orleans at a quarter a dollar per head, and letting her out for balls at half a dollar per head, and intended to form a syndicate for the purpose. He entered into negotiations with the secretary of the Great Eastern Steamship Company to charter the ship, and to pay for her £6,000 or £7,000 during the Exposition, with the option of purchasing her for £45,000 at the termination. He failed to form the syndicate. The defendant, who was then in this country, but was now in America, formed a syndicate, and chartered the vessel for £7,500, and the ship was now about to leave under the charter party. The plaintiff sought to restrain the vessel from sailing on the ground that he had virtually chartered her.—Mr. Justice Kay, without calling on the defendants, held that there was no evidence that the plaintiff had ever made any definite arrangement, or that his terms had been conclusively accepted by the Great Eastern Company. The defendant had, however, chartered the vessel. The motion must therefore be dismissed with costs.

UNIVERSITY COLLEGE, LIVERPOOL.—Principal Rendall and the professors of the Liverpool University College, Ashton-street, received the day and evening students at that university on Thursday and Friday evenings. All parts of the college were thrown open for inspection, and the students, along with their lady friends, were received by Principal Rendall in the examination room, on the upper floor of the institution. In the natural history laboratories, various specimens, diagrams, and models were set out for inspection, and numerous minute animals and other objects of interest were shown under the microscope. Scientific apparatus, electrical and otherwise, were exhibited and explained in the physical laboratories by several of the professors of the college. Early on in the evening, Professor Herdman exhibited, by means of the oxy-hydrogen lantern and the microscope, a series of illustrations of animal life in the surface waters of the ocean, which exhibition was accompanied by an explicit lecture of the habits and the whereabouts of the species of life which he exhibited.

ELECTRIC LIGHT IN BIRMINGHAM.—The Incandescent Electric Lighting Company (working on the Crompton-Winfield system), which obtained an order under the Electric Lighting Act to supply current in parts of Birmingham, has given notice of a Bill in Parliament to vary the terms of the order, under which the company was required to sell the undertaking to the Corporation, as a going concern, at the expiration of sixteen years from the date of the concession (1883), and was also required to lay down certain mains within a period of two years, to maintain a constant supply of current, and to secure within six months a certain sum of money as capital for electrically lighting the assigned district. Owing to practical difficulties it has been found impossible to comply with the terms of the order, and with the consent of the Corporation, together with the sanction of the Board of Trade, an extension of time has been granted. The company now asks Parliament that the term for the deposit of capital shall be extended to two years from the passing of the Act; that power be taken to vary the assigned district from time to time, with the consent of the Corporation; that a compulsory supply of current to consumers be not required for a longer period than twelve consecutive hours; that the limit within which the commencement of supply shall take place be extended from two years from the date of the order, to five years from the passing of the proposed Act; and, lastly, that "the period within which the Local Authority may purchase the undertaking be within six months after the expiration of thirty-five years from the passing of this Act.

COMBINED ENGINE, DYNAMO, AND SEARCH LIGHT.—The French Minister for War appears to have definitely adopted two sizes of a combined arrangement of steam engine, dynamo-electric machine, and search light for guarding against night attacks, and for searching the battle-field after an engagement. The larger size includes a Brotherhood engine, with vertical Field boiler mounted on a 4-wheeled truck and a pair of large wheels; a Gramme dynamo, the armature of which makes 1,200 revolutions a minute, giving a current of 68 to 70 amperes, and a difference of potential at the terminals of 38 to 40 volts; and a Mangin aplanetic mirror. The latter possesses the same property as the parabolic mirror, that of making parallel the rays from a source of light placed in its focus, and has the great advantage over the latter that it may be ground by mechanical means. This mirror is set in the end of a short, slightly conical, sheet-iron tube, inside which is placed the arc lamp, which may be adjusted so as to occupy the exact focus. After numerous trials, it has been found possible to entirely exclude automatic regulators, and only to use hand-regulated lamps. The maximum of light, which is in this case 33,000 candles, is obtained when the positive carbon, which is a little behind the negative with respect to the mirror, has a vertical face, thus sending a flood of light on the mirror. The lamp has two carbon holders, which a double-threaded screw permits of bringing together as the carbons are consumed, so that the arc always preserves the same position—that is to say, the focus of the mirror. When the apparatus is in use, the lamp and mirror are dismounted from the carriage and placed on a convenient stand.

MECHANICAL EFFECT OF ELECTRIC DISCHARGE.—The following is a translation of the abstract, made by E. Villari, of his paper on "Singular Mechanical Effect of the Electric Discharge," published in the *Proceedings* of the Bologna Academy of Science:—When an attempt is made to pierce a sheet of thin glass by means of an electric discharge, it often happens that the spark glides over the two surfaces of the sheet without breaking it. But, if the same operation be performed on a glass plate of moderate width and silvered on one side, it may readily be broken by the discharge, although several millimetres thick. Similar results are obtained if a strong spark be made to glide over the silvered surface only of the glass. I have in this way succeeded in cracking plate glass 7mm. (¼in.) thick, some of thickest I possessed. I have succeeded in breaking two glass plates, together 16mm. to 17mm. (⅝in.) thick, placed together with their silvered sides outside, by causing to burst upon them, by means of the spinterometer, the discharge of a six-jar battery containing 96 electrical units. For the discharge to produce this pheno-

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menon, it must glide over the silvered face of the plates; and the effect produced may be compared with that of a ram or hammer blow. I think I may attribute it to the sudden volatilisation of the silver layer. In fact, this effect of the discharge increases in energy with the quantity and with the potential of the charge. The edges of the glass thus broken present a conchoidal appearance; and the lines of the fractures appear to proceed from each of the two poles to the opposite face, while diverging from one another. These lines, by their direction, recall magnetic *spectra* or diagrams of lines of force.

QUANTITY OF ELECTRICITY.—M. D. Thommasi, in *Kosmos*, says that this expression, which recurs continually in practice as well as in theory, is not always understood, and requires more explicit definition, so as to avoid all misconception. It is specially in electrolysis that the "quantity of electricity" plays an important part, and with it the expressions "electrical equivalents" and "electro-chemical equivalents." Reference to the tables contained in electrical treatises show that to liberate, for instance, 4·05 grammes of silver requires a current of 1 amp.-hour absolutely, as is the case to liberate 1·05 gramme of iron, 1·19 gramme of copper, 1·11 gramme of nickel, &c. This, continues M. Thommasi, is perfectly correct, provided that in each case the number of volts accompanying the amp.-hour correspond with the quantity of heat absorbed by the decomposition of the electrolyte. This E.M.F. acquired, the metallic deposit will take place in proportion to the intensity of the current. When "electrical equivalent" is used to mean the quantity of electricity necessary to decompose a molecule of any substance whatever, it is evident that intensity of current and not E.M.F. is meant. It follows that this expression, which relates to only one of the factors of energy, seems to refer to the product itself—that is to say, to the electrical energy. To avoid this confusion, it would be well to complete the tables of electro-chemical equivalents by an indication of the *calories* of combination expressed in volts of each compound. In this way, it would be known that, for an amp.-hour to decompose 2·98 grammes of sulphate of copper, 3·02 grammes of sulphate of zinc, &c., it will be necessary that the current have at least an E.M.F. equal to 1·4 volt for the sulphate of copper, and an E.M.F. equal to 3·46 volts for the sulphate of zinc.

PERSONAL SAFETY AND ELECTRIC CURRENTS.—Professor A. E. Dolbear says: The serious accidents which have occurred within the past four or five years through accidental contacts with wires carrying strong electric currents have seemed to call attention to the necessity of providing safeguards against such mishaps. It is probable that carelessness has been the cause of most of the accidents reported, and it is true that if weak currents only were used nobody could be hurt. It is, however, worth while to consider the electrical relations of the human body, in order to learn where danger lies. I have noted in various places the opinions of different persons as to what constituted a safe current. In one of the old books it is stated a "a spark 18in. long begins to be dangerous." In another place one says that a difference of potential of 800 volts is too high an electromotive force for individual safety. Now a difference of potential of 1,000 volts will not give a jumping spark the hundredth of an inch long. The electromotive force developed by the Holtz electro machine may be as high as 50,000 volts, and the spark from it will at most give a spasmodic jerk to the elbow and no manner of hurt come of it or of repeated shocks from it, so that more than difference of potential must be considered in determining what is dangerous about electricity. The ability of electricity to do work of any kind, destructive physiological work as well as any other, depends upon both difference of potential and current strength, and the amount of work is proportional to the time also. Now, the discharge from a Holtz machine through a short wire may give a very strong current; for example, let $E = 50{,}000$ volts, $R = \cdot001$ ohm, then $\frac{50{,}000}{\cdot001} = 50{,}000{,}000$—fifty millions of amperes; but the wire may show no sign of being injured, for the time of the current passage was too short, probably less than the millionth of a second. If the discharge had continued for an appreciable part of a second the wire would have been vaporised. The discharge is probably equally quick when taken on the knuckles, but there is not enough energy to hurt anything. Again, the amount that will traverse any conductor, with a given difference of potential between its ends, will vary inversely as its resistance, and for the human body it may only roughly be calculated. The resistance of the body is very great. Many measurements, made with different individuals taking wires in their fingers and hands, gives a resistance varying between 6,000 and 15,000 ohms; but this depends in a large degree upon the moisture of the skin when contact is made. Hands which are ordinarily dry have a high resistance; the same hands moist with perspiration or purposely wetted may lose half their resistance. Dr. Stone, of London, has made many experiments, and finds that the resistance of the body may be reduced to 500 ohms or less, by having the skin soaked. On an arc light circuit with forty lamps the difference of potentials will be about 2,000 volts. If a man with a dry, thick skin were to grasp the terminals at the dynamo, the current that would go through him would be $\frac{2000}{10000} = \cdot2$ of an ampere, and in one second two-tenths of a coulomb would have traversed his arms. If the same hands were soaked, the current might be $\frac{2000}{500} =$ 4 amperes, or 4 coulombs per second. In the first case there would have been spent in him an amount of energy equal to $2000 \times \cdot2 = 400$ watts, or more than half a horse-power, and in the second case $2000 \times 4 = 8000$ watts, or $\frac{8000}{746} = 10$ horse-power in the interval of one second. Now, any electromotive force above about 1·5 volt is sufficient to decompose water, and it has been shown that the fluids of the body are better conductors of electricity than any of the tissue, even the nerves; it may fairly be inferred that such a current with such an electromotive force might decompose a notable quantity of the fluids of the body into their constituent gases. To determine the highest limit of safety would require experiments which no human beings would be willing to submit to. Animals might be employed perhaps; but if 800 volts have at any time proved to be dangerous, one may set a lower limit to the resistance of the body and determine the current strength $\frac{800}{1000} = \cdot8$ amperes. That result looks threateningly large, but it is because the resistance is made so low. I have never found one less than 500 ohms, then $\frac{800}{5000} = \cdot16$ ampere. But that represents 128 watts—a quantity of energy no one would care to have spent in him. After all, what would be safe for one would be entirely unsafe for another; so that each individual would have his own factor of safety, or the difference of potential which he could work with with impunity. From what we now know it would seem as if one-tenth of an ampere current body was as much as any one could safely have traverse his body for one second. If, then, he fixes his minimum resistance, the product of the two will give him the electromotive force which he may feel timidly safe with. Thus, if one's resistance with wet hands is found to be 8000 ohms, then $8000 \times \cdot1 = 800$ volts; while if his resistance was only 1000 ohms, he could only venture to touch wires having a difference of potential of $1000 \times \cdot1 = 100$ volts. The ordinary incandescent light circuit would be on his limit.

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SILVANUS PHILLIPS THOMPSON.

THOMPSON, SILVANUS PHILLIPS, was born at York in 1851, of an old Quaker family. The Thompsons of Westmoreland and Cumberland trace back many generations, and they number, amongst various collateral branches, the family of the present Archbishop of York (who, however, dropped the "p" out of his name). The subject of this notice was educated at the Friends' School, York, an institution which has done much for pioneering scientific education. It boasts of the oldest school natural science society in existence. He subsequently studied at the Founders' College, and in 1869 graduated B.A. of London University. Having, however, a preference for science rather than literature, he studied to qualify himself for the post of science-master in his former school at York. This post he abandoned for the sake of further study of chemistry and physics, and pursued courses in these subjects at the Royal School of Mines, supplemented by visits to the University of Heidelberg and other foreign institutions. In 1875 he graduated as Bachelor of Science of the University of London, being bracketed first in Honours, and in 1878 he took the further degree of Doctor of Science, selecting experimental physics as his subject for examination. Meantime he had been acting as Lecturer in Physics in the then newly-established University College at Bristol, and had also begun to lecture under the Gilchrist Educational Trust. In 1878 he was appointed to the Professorship of Experimental Physics in the Bristol University College, a post which he still holds. In connection with this chair he has, in addition to usual academical courses of lectures, delivered courses upon the Technical Applications of Electricity upon Sound in relation to Music, and a special course of Technical Physics for Engineers and Builders. He has had the onerous duties not only of lecturing on Experimental and Mathematical Physics in the College, but of organising the Physical Laboratory of the College, a task rendered the more difficult from the circumstance that this organisation had to be accomplished in the complete absence of any available endowments for the purpose, and in the teeth of great commercial depression. His perseverance and energy, however, eventually secured success; partly by the delivery of lectures in various places in the district, and partly by contributions from friends of the College, and from his own modest salary, Professor Thompson was able to get together funds for the furnishing of the nucleus of the needful apparatus.

From the time that he entered on his duties at Bristol Professor Thompson has made important contributions to contemporary science. The reports of the Physical Society of London and of the British Association bear witness to his zeal as a physicist, and his insight as an inquirer into physical, and chiefly electrical, phenomena. His investigations range from the chromatic aberration of the eye to the form of coils in the tangent galvanometer. He is at home in the problems of binaural audition, and in the theory of the magnetic balance. The curious optical illusion known as the "strobic circles" was his discovery; and his application of the magnetic figures formed with iron filings to the illustration of electro-dynamic relations, and to the elucidation of the action of the dynamo-electric machine, are well known. The researches of Antoine Breguet were avowedly based on an earlier result of Professor Thompson's. Professor Thompson also has the honour of having applied Clerk Maxwell's electro-magnetic theory of light to the explanation of the behaviour of tourmaline crystals in their action upon polarised light; and he has even constructed electro-optic models of these crystals out of iron wire and glass. In the course of this investigation, which was largely mathematical as well as physical, he brought out a new proof of the fact—still not quite regarded by some physicists as settled—that the displacements in a wave of light are perpendicular to the so-called plane of polarisation.

Professor Thompson is, however, better known by his work amongst the applications of science than in the more recondite fields of abstract physics. His studies upon electrical storage, and upon dynamo-electric machines are known to all electricians, and have received the recognition of the Society of Arts by the award of two silver medals. His Cantor Lectures on the latter subject, delivered in the autumn of 1883, at once established his reputation of being among the foremost in the special study of the construction, theory, and mode of working of dynamo-electric machines. The lectures then read before the Society of Arts formed the first really practical effort that had been made to examine this subject with anything like clearness and a thorough grasp. They proved such a useful addition to the current literature of the subject that the reprints issued by the Society and by the publishers were speedily exhausted. They were translated into French, and in part into German. They were pirated by an enterprising bookseller in New York. This demand induced Professor Thompson to undertake the much more extended treatise on the subject recently published by Messrs. Spon, and of which a second English and a French edition is already announced. According to the critics, this work is conspicuous not only for the logical completeness of its method, and for the practical nature of its teaching, but for the thorough impartiality maintained by the author in questions of priority of invention. Almost equally remarkable has been the success of Professor Thompson's "Elementary Lessons in Electricity and Magnetism," a work which, to judge by its extensive and world-wide use, is worthy of its place beside Roscoe's "Chemistry" and Huxley's "Physiology" in the well-known series issued by Messrs. Macmillan. Professor Thompson has published several other works, including a biographical notice of Philipp Reis, whose invention in the years 1860 to 1863 of the telephone that bears his name had been almost lost sight of in the fame of later improvements, a study of Apprenticeship Schools in France, and several pamphlets on Technical and Scientific Education.

Professor Thompson is no bookworm, however. A vivacious and fluent lecturer and an eager debater, he is equally ready with his pencil as with his pen or his tongue. It is an open secret that he is often the draughtsman of his own diagrams; and he is known to his friends as an amateur artist, with a keen eye for colour. His water-colour landscapes have been seen and admired on the walls of the Dudley Gallery, and in the exhibitions of the Local Acadamy of Bristol. He possesses a library of electrical literature believed to be second only amongst private collections to that of Mr. Latimer Clark. Original works of Volta, Galvani, Franklin, and even of Gilbertus, may be found amongst the treasures thus collected.

The views of the younger generation of electricians are perhaps not inaptly typified by those of Professor Thompson. He is a thorough believer in the electro-magnetic theory of light, and in the existence of electricity as an entity

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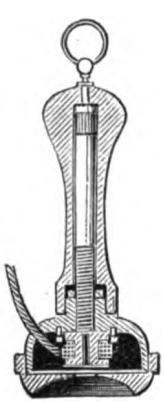
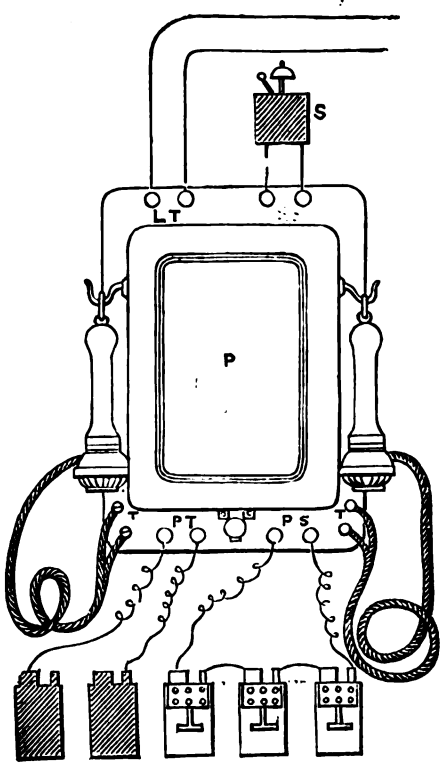
distinct from both matter and energy, though capable of being associated with the one, as also of serving as the vehicle of the other. In the dispute as to the origin and seat of electromotive force in the voltaic cell he holds firmly to the "fuel" theory—that is to say, that where the energy of the zinc, the fuel of the current, is being given out, there is the seat of the electromotive force. He spoke vigorously in the late debate at Montreal in support of this view, and exposed the fallacy introduced by Sir W. Thomson in limiting the definition of the potential of a body to the potential at some adjacent point in the external air. He regards the dynamo-machine as the central focus of electrical progress, and its relation to the science of electricity as the exact counterpart of the relation of the steam engine to the science of heat. His investigations and teaching in respect to this special subject have already borne practical fruit in various directions. Not a few of the latest forms of dynamo-electric machines may be said, without exaggeration, to bear in some point or other the impress of Professor Thompson's labours.

MAICHE'S ELECTROPHONE.

In this instrument the transmitter and receiver are now combined. The transmitter originally consisted of two distinct portions: a vibrating plate receiving the sound waves, and an organ transferring them into electric waves. The invention consists in the arrangement, on two parallel lines, of any number of carbons, separated by a certain space and breaking joint, so that the spaces between two consecutive carbons of the same line are opposite the carbons of the second row. These carbons carry others laid at right angles to the preceding, so that their ends rest on two of the carbons in the first row. The vibrating portion consists of a glass bell on which are placed the carbon contacts, as near the edge as possible. A battery current traverses all the carbons, which vibrate with the bell on speaking into its mouth. These vibrations cause differences of pressure between the carbons, and consequently induce currents in a coil, which currents are transmitted along the line for actuating the receiver. M. Maiche now uses a microphone formed of four or six diaphragms arranged in a circle, and provided with



an equal number of small bells, all included in one of larger size, the office of which is to concentrate the waves and distribute them to the small bells. The diaphragms are quite small, being cut out of thin cardboard and varnished so as to be damp proof. At the centre of each of these diaphragms, and at the back, is fixed a carbon lozenge, on which rests the contact which has to produce the microphonic effects. This contact consists of a small carbon ball, suspended by a copper wire to a jointed arrangement. The core of the induction coil is formed of a magnetised bar, the armatures being iron plates serving as telephonic receivers. The current which passes through all the contacts arrives at the primary helix of this coil. The latter, in its turn, reproduces the sounds when the transmitter is not acting, and actuates the telephones of the second station when the transmitter is in action. The circuit is thus free from telephone coils, which generally render hearing difficult. A recent improvement consists in fitting the bar (as shown by the accompanying section), not to the handle but to the mouth, by means of a screwed portion which permits of adjustment so that it cannot be displaced by the deformations of the handle. The mouth itself is of cast brass nickelised; and the nut of the screwed bar is arranged on the plate which carries the



coil. In the accompanying diagram of transmitter and receiver, S is the call-bell and battery; and P the diaphragm.

NEW ARC LAMP.

A correspondent, "G. M.," in *Kosmos* gives an account and illustrations, which we reproduce, of a new arc lamp, without, however, mentioning the name of the inventor. Although the light is not so constant as in more complicated lamps, it is said to be sufficiently so for all ordinary purposes.

The upper carbon holder H L is a tube which slides with gentle friction in holes made in the frame or case with which it is electrically connected. The lower carbon holder M N is insulated from the frame, and is in communication with one end of the lead, the other being directly connected with the generator by means of the binding screw T, also insulated from the frame.

The mechanism which regulates the descent of the carbon holder L H consists of a brake, A B, partly shown by dotted lines; the essential portion, however, appears through a breaking away (in the cut) of part of the conical electro-magnet coil V. This brake, which forms part of the electro-magnet, is pivoted at C. It will be seen by the form given to the end B, which comes in contact with the upper carbon-holder, that, in proportion as the end A is attracted by the electro-magnet, the tube H L will be held tightly between the end B and the spring R. The position of the brake is regulated by two screws, D and F, the former acting on an opposing spring, P, and the latter on a lever, E, which limits the travel of the armature.

When no current passes, the tube H L is free to descend; and the two carbons come in contact. The lamp is then in a condition to act; but when the circuit is closed, the armature being attracted, the carbon-holder becomes fixed. It follows

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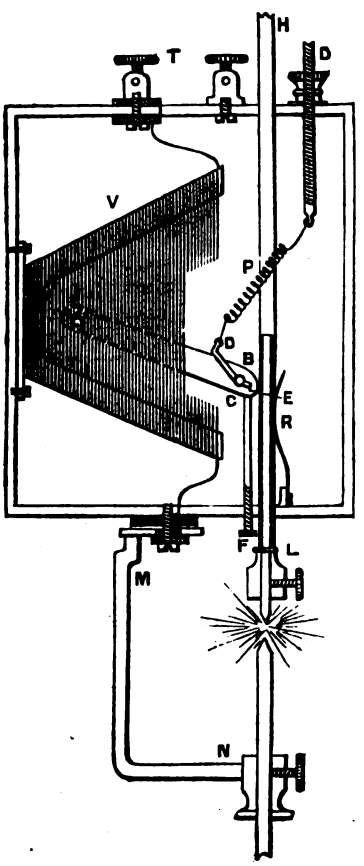
that, in a second, as the ends of the carbons are consumed, the luminous arc appears between the two points. The position of the armature will have been regulated beforehand by means of the screws D and F, so that, when the carbons are no longer in contact, and the arc gives its maximum of intensity, the degree of screwing will be sufficient to keep the upper carbon fixed. When the arc tends to elongate, the intensity of the current is reduced ; and, at the same time, the attraction of the electro-magnet also diminishes The end A of the brake being then less attracted, and acted upon in a contrary direction by the spring P, will rise, thus diminishing the degree of tightness with which the upper carbon-holder is held at B. The latter will then slide, and the arc be shortened ; but at the same time the current resuming its original intensity, the brake will again act as soon as the arc attains



its normal length. The upper carbon-holder moves very slowly in exact proportion as the carbons are consumed.

CONDITIONS OF EQUILIBRIUM OF A LIQUID BAND, SUBJECTED TO ELECTRO-MAGNETIC ACTION.*

BY G. LIPPMANN.

When a liquid, traversed by electric currents, is at the same time subjected to the action of magnets fixed in its neighbourhood, electro-magnetic forces are generated which tend to displace each element of the current. These forces have their points of application in the very substance of the liquid mass. It is therefore possible, by their intervention, to realise cases of equilibrium or of more general motion than that generally presented in hydrostatics. Moreover, the conditions of equilibrium may serve to illustrate the properties of the *coupures*, which serve to render a function uniform with a given space.

Let a very thin and horizontal band of conducting liquid be traversed by electric currents brought to it by electrodes arranged in any suitable manner, and let it be at the same time placed in a vertical magnetic field of uniform intensity, H. It is required to find the conditions of this equilibrium.

* Academie des Sciences, 3rd November.

At a point of the liquid, of which the rectangular co-ordinates are (x, y), the intensity of the current is such that the components parallel with the axes are $K\frac{dV}{dx}$, $K\frac{dV}{dy}$, K being a constant coefficient and V the electric potential at the point under consideration ; V is a function of x and of y, subjected to satisfy the equation

$$\frac{d^2V}{dx^2}+\frac{d^2V}{dy^2}=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

The electro-magnetic force is normal to the direction of the current, and therefore has for components :

$$X=-HK\frac{dV}{dy}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$Y=HK\frac{dV}{dx}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Lastly, calling p the hydrostatic pressure at the point (x, y), the necessary conditions of the equilibrium are

$$X=-\frac{dp}{dx}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

$$Y=-\frac{dp}{dy}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

What are the sufficient conditions ?

To find them, be it remarked in the first place, that from the equations (4) and (5) are obtained

$$\int(X\,dx+Y\,dy)=\int\frac{dp}{dx}\left(dx+\frac{dp}{dy}\right)dy. \quad . \quad (6)$$

It is necessary that the second member, which is no other than the equation of the hydrostatic pressure p, be a uniform function of x and y. The same is therefore the case with the first member. From equations (1), (2), and (3) are obtained

$$\frac{dX}{dy}-\frac{dY}{dx}=0. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

The condition of integrability (7) is therefore a consequence of the equation (1). In order that, besides the function of x and y, represented by the first member of the equation (6) be uniform, it suffices that the space occupied by the liquid be of suitable form, or that it be divided by appropriate separations which may be partitions impermeable to the liquid, but permeable to electricity. In that case equilibrium exists. In fact, from the equations (2), (3), (4), and (5) are obtained

$$\frac{dp}{dx}=HK\frac{dV}{dy}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\frac{dp}{dy}=-HK\frac{dV}{dx} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

These equations signify that the curves $p=$ const. are orthogonal, or conjugate of the curves $V=$ const. As the values of V are given, being those corresponding with the given electric current, the same is the case with those of p. It is thus especially with the values of p along the partition.

To sum up, whatever be the form of the space occupied by the liquid and the distribution of the electric currents, it is necessary, and it suffices for equilibrium, that this space be limited by partitions arranged as *coupures*, which would render uniform the conjugate function of the electric potential. The law as to the pressures developed along the contour is the following:—These pressures have values conjugate with those of the electric potential along the contour.

It follows, then, if the given space be of simple connection, there is always equilibrium; and this is specially the case with the mercurial galvanometer which I have had the honour to submit to the Academy. Inversely, in the experiments of Faraday and the apparatus of M. Bertin, intended to show the electro-magnetic rotation of a liquid, the space occupied by it is always of multiple connection.

AFGHANISTAN.—The latest idea of the Ameer of Aghanistan, says *The Times*, is to illuminate Cabul by the electric light. It is stated that he has sent some officers to Bombay to make the necessary arrangements.

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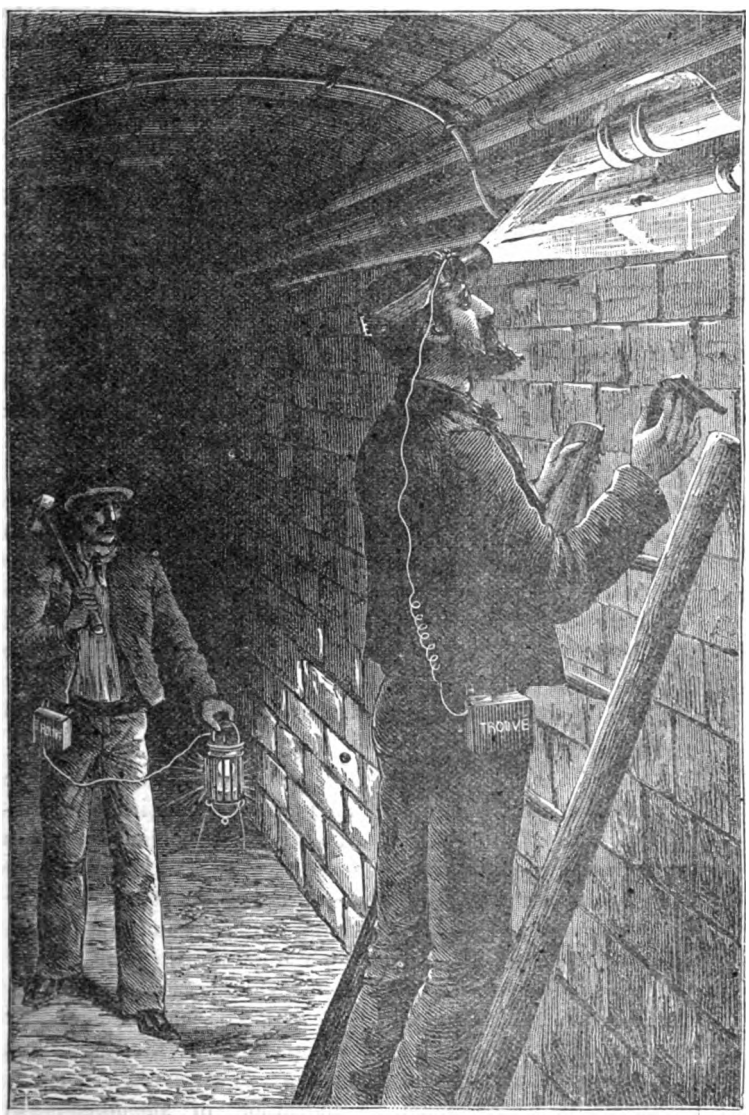
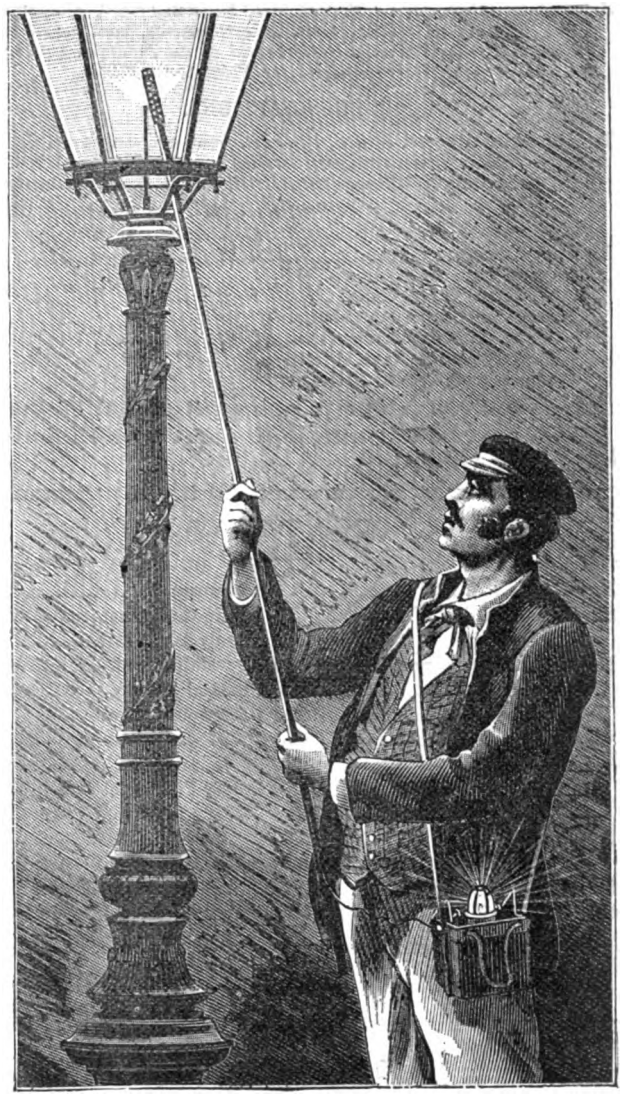
APPLICATIONS OF TROUVE'S LAMPS.

We have already described and illustrated M. Gustave Trouvé's electric jewellery and his portable electric lamps, which latter are a development of the scientific playthings, and we now illustrate some practical applications of the portable lamps.

The first view shows an *employé* of the Compagnie Parisienne du Gaz making use of the electric light under the form of an incandescent lamp, fitted into a powerful conical reflector, and worn on the forehead, so as to throw its rays on the spot to which the sight is directed. The current is supplied from one of Trouvé's portable

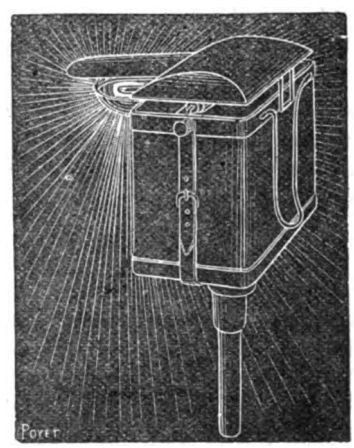




bichromate batteries, slung across the shoulder. The man is in a subway, searching for a leak in the gas main, so that it may be reasonably supposed that the atmosphere is so highly charged with gas as to be explosive; but there is no danger of ignition even if the lamp were to burst, because it is surrounded with an outer glass, while the space is filled with water or nitrogen.

The second view shows another of the Paris Gas Company's men lighting a street lamp by means of an electric lighter, supplied with current from the battery of the portable lamp slung over his shoulder, and which may be so arranged as to shine or not as required. The remaining figure shows the arrangement of carriage lamp, which is self-contained with battery, and may be used with the existing lamp sockets. The light is five or six times as powerful as that of the ordinary candle lamps, and permits, it is said, of reading inside the carriage at night. Large numbers of carriages fitted with these lamps may be seen on the Paris boulevards. There is yet another and very important application of the Trouvé self-contained portable lamps; and that is in theatres which are still lighted by gas instead of by the safer and more wholesome electric light. A few of these lamps disposed about the auditorium would be consuming no battery force until wanted; but, on an extinction of gas occurring, they would, when taken up, reassure a panic-stricken throng, and probably prevent one of those sad catastrophes of which only too many have lately occurred.

A note in *L'Electricien* on these lamps says that the domestic battery, charged ready for working, weighs 3·5 kilogrammes (7¾lb.) It contains six bichromate elements in tension, each one of which consists of one zinc and three carbon cylinders, with a provision of 100 cubic centimetres (6 cubic inches) of solution. The weight of each zinc cylinder, amalgamated with from 8 to 10 per cent. of mercury, is 85 grammes (1,312 troy grains) or 500 grammes (1·1lb.) for the six elements. The E.M.F. was found at the Ecole de Physique et de Chimie Industrielles to be 1·9 volt, and the resistance 0·35 per element. Under the conditions of maximum power they can therefore give out 3 amperes. Actually the six elements coupled



in series on the lamp yield an available current at the terminals of 8·4 volts at 1·2 ampere per element.

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LETTERS.—*Three letters awaiting "Electric Star" at this office.*

SCIENCE GUILDS.

With the spread of scientific knowledge and the increased public favour extended to scientific research the relations between the guilds of learning and the outside world have been materially altered during the last quarter of a century. Or rather we should say the obligations have been altered, the fact being that their relative positions have remained unchanged, while the duties, one to the other, have undergone a complete transformation. Notwithstanding the complaints of certain grumblers at the non-endowment of science, it is an indisputable fact that the liberal expenditure of money upon scientific objects, and the popularity of scientific professors constitute an endowment which is of considerable market value, and one which, if not in excess of their deserts, is certainly beyond the highest hopes of the past generation of scientists. And this being so, it becomes a question whether the close Guilds which were founded under wholly different conditions should any longer maintain their exclusiveness and comparative isolation. We do not propose at this moment to go fully into this wide question; but briefly we may here state our conviction that in several highly distinguished quarters they seem to be unaware of the fact that they nowadays do not possess a monopoly in cultivating the fields of science, and that the fruits of their labours have ceased to be their own exclusive property.

One noteable illustration of this is furnished in the publications occasionally issued from the press of these ancient seats of learning. Their meetings are for the very elect of the scientific world, and the papers read on these occasions are presumably worthy of their audience. They are, in fact, very often of the highest possible importance; yet nobody hears them but the select few, and nobody knows of them until the period arrives, at rare intervals, for publishing the society's doings in the form of "Proceedings" or "Transactions." By that time the subjects, or many of them, have lost all their interest, and the volume containing them is so costly and so bulky that only a few people can afford either the money or the time to become masters of their contents.

Some grave inconvenience arises out of this dilatory and reticent habit, as was seen in a recent case brought to light in this journal, where an independent discovery was made and a paper explaining it read at one society, whilst a similar discovery had been made and explained a good while before at another society, but had not been announced to the public through the ordinary channels of scientific communication. It is true that by the time the second discoverer had delivered himself the first discoverer was able to point to his prior title then actually in print. It was in print certainly; but in such company, in such shape, and so long behind date that only the most indefatigable and omnivorous of readers would ever have come across it. In short, the so-called "Transactions" and "Proceedings" are mere records—valuable undoubtedly as records; but for any educational or enlightening purposes outside its own charmed circle the society might just as well keep the original manuscripts in its own lockers.

Our opinion, on the contrary, is that their doings should be made known to the public in an ungrudging spirit and without any delay. The extent to which subsidiary scientific bodies have sprung up, and the progress of scientific journalism in recent years are proofs of a widespread interest in scientific research; and there is something ludicrous in those bodies claiming to stand highest in reputation refusing any mutual intercourse either with their humbler followers or with the press, which alone can make their title to repute accepted by the outside public, and yet complaining of the public not recognising the claims of science as it deserves. We are thankful to acknowledge an indication of amendment in respect to Professor Tyndall's Christmas lectures at the Royal Institution, which by his courtesy we shall be able to report in full. This is as it should be; and we hope the example will not be lost upon other learned societies.

We cannot, however, acquit some of the subsidiary societies of faults equally grave though of a different kind. Their meetings are open enough, and their Proceedings are not inordinately delayed in publication. Neither do they discourage reporting, except perhaps when they happen to have a grudge against a particular journal. But in their organisation and management there seems very little to choose between them and their more aristocratic parent societies. The tendency to exclusiveness grows upon them; and the form it takes is to treat the members as if they did not form an integral part of the Society, or at all events to assume that its Council is the Society. Our last week's account of the annual meeting of one of these bodies illustrates what we mean. Election of new members on the governing Council is supposed to take place on these occasions; but in reality

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the proceeding is a mere formality, the council nominating their successors, and the meeting ratifying their choice. Formerly they submitted several alternative names, and the members made choice; but even this small piece of indulgence has been withdrawn, and there is nothing now to be done but to vote for the Council's nominees, and try to look edified.

Members of societies governed in this way are reduced to nonentities so far as their influence on its councils is concerned. The selections may be unexceptionable; but made in this fashion they are apt to be criticised and objected to in private, and at best are not likely to secure the confidence of the whole body of members. As far as administration goes, perhaps, it matters very little; but for the selection of papers to be read, the attraction of fresh members to its fold, the introducing of fresh activities into the society, this hole and corner method of electing the administrators is decidedly detrimental. The Society of Telegraph-Engineers and Electricians, in which our readers take a warm interest, may be wise to consider this subject before another election takes places. Meanwhile, despite all shortcomings, we beg leave to wish these Guilds of Science without exception a merry Christmas and a very prosperous New Year.

CORRESPONDENCE.

THE ELECTRIC LIGHTING ACTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I observe in your last issue a list of the members of a committee promoted by the Anglo-American Brush Electric Light Corporation to confer with the Board of Trade on the amendment of the Electric Lighting Act and Provisional Orders of 1882 and 1883. A brief examination of the names and connections on that list will suffice to convince anyone that it does not fairly represent the electric lighting industry. The Anglo-American Brush Company and the Edison and Swan United Company are no doubt by arrangement in the majority, and that these two companies govern the committee is proved by the election, by ballot, of ten of those members to form the executive committee, all of whom, I believe, belong to or are connected with one or the other of the two companies before named. It is obvious that such a committee is not representative; it does not represent a hundredth part of the interests involved, and on that account, if it is to have the confidence of the body of electric light engineers and others interested, and to be in a position to carry through such alterations in the Electric Lighting Act and Provisional Orders as are considered necessary, it should be remodelled to include:—

1st. Other Electric Light Companies (in a fair proportion).

2nd. Kindred Companies, such as Telegraph Cable and Wire Companies, Steam, and other Motive Power Companies and Firms.

3rd. Private Electric Light Contractors.

4th. Consulting Electric Light Engineers, Borough Engineers, &c.

5th. Civil and Electrical Engineers generally.

It is a well-known fact that private electric light firms are doing more business in electric lighting than all the companies put together; and it is obviously unfair that they should not be represented.

In its present form the executive committee only speaks for the two companies, viz., the Anglo-American Brush Electric Light Company (Limited), and the Edison and Swan United Electric Light Company (Limited), and only represents company interests, at present the weakest of all the electric lighting interests; and unless the committee be remodelled I would advise the private firms and others I have indicated to form a committee to look after and advance their own special interests. I should like to know how the committee will work with that appointed by the "Dynamicables." The "Dynamicables" have produced a very excellent and well-timed report on the subject, and they are far more representative than the two companies can ever be.

At a recent meeting of the "Dynamicables" I pointed out the advisability of their working and presenting their report in conjunction with the Institution of Civil Engineers, the Society of Telegraph Engineers, and other such well-known and established societies. I would suggest that instead of the disjointed and weakened efforts of special and independent committees, that the proper and most forcible way of obtaining the repeal and alteration of the Electric Lighting Act and Board of Trade Provisional Orders will be by a combination of the companies' committee, the "Dynamicables," and as many of the undermentioned institutions and societies, and such like, as may be induced to join, viz.:—The Institution of Civil Engineers, the Society of Telegraph Engineers, the Royal Society, the Royal Institution of British Architects, the Society of Engineers, the Society of Arts, the Iron and Steel Institute, and others, the arrangement and management to be placed in the hands of the "Dynamicables," who have shown themselves eminently qualified for such a position. Such a combination, representing, say, 50,000 men all more or less specially interested in the subject, would be all-powerful to fight the large competing interests of the gas companies, and to deal with the local authorities. The labours of such a combination would be treated with the respect due to the large body of the best class of men in the country they represent. I submit that all the societies mentioned, the companies and private firms who all desire the advance of electric lighting, would assist in such a combination, and help us to get out of the present slough of despondency, brought on by disreputable company mongering and interested cliques. The favourable revision of the Electric Lighting Act and Provisional Orders is necessary, and would materially help the electric lighting industry, and no doubt lead to the public lighting of large areas. The interests involved in such work are enormous, and it behoves all who wish to share in the prosperity in prospect to unite to prevent the combination of any two or more companies from practically arranging the terms to suit their own special schemes, and monopolising the advantages at the same time, with very doubtful chances of ultimate success in securing alterations at all. On the other hand, a combination such as I have outlined would have the confidence of every one, and would, no doubt, be able to secure the alteration in the Acts and Provisional Orders we all so much hope to see. May I request your own views on this all important matter?—Yours, &c.,

HENRY F. JOEL.

Tower Chambers, Moorgate-street, London,
E.C., Dec. 22, 1884.

THE WIMSHURST MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of 13th inst., p. 82, under the notice "Catalogue—Messrs. King, Mendham, and Co., &c."—there appears to be a grave error in the description of the Wimshurst machine, as follows:—"The electricity is collected from these straps by wire brushes, &c.," to end of paragraph. This whole paragraph is entirely wrong, as the only apparent office that the wire brushes perform is to put two opposite strips of brass on same diameter of disc into electrical connection, twice in each revolution, and which is essential to the working of the machine. The collectors are entirely separate, and on the horizontal axis of the plates, and may be removed without affecting the working of the machine, and if so removed the electricity is given off from certain parts of the plates in a copious brush discharge, and the peculiar smell of ozone is very perceptible at a considerable distance. In order to obtain the maximum effect, it is necessary that the two rods carrying the brushes should be set at an angle of 45° from the horizontal axis of the discs, and at right angles to one another; and by revolving the plates

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in the contrary directions, the electricity will be produced in the two vertical sectors of the plates, and not in the horizontal sectors. The same may be done by altering the position of the brushes and revolving the plates in the original direction. I have a machine, more or less made by myself, with plates 19½in. diameter, with twenty pieces of brass on each plate, and as each plate revolves 200 times per minute, the pair of collecting combs, connected with each electrode, take electricity from no less that 8,000 pieces of brass per minute. The machine is a most interesting one, but I am unable to explain its action, though it is said to be on the principle of the electrophorous; at any rate, its efficiency is remarkable, and it seldom reverses its polarity, but its construction is attended with many mechanical difficulties. The machine that I have is made very substantially, and mounted on a special table with an arrangement for a lamp to dry the plates in damp weather, and with this lamp I have no difficulty in working the machine in all weathers and obtaining good results even in a close and crowded room. I do not see why the machine should be called "Influence." I should have thought Inductional would have been a better term.—Yours, &c., W. KNIPE, Lieut.-Col.

POCKET ACCUMULATORS.

TO THE EDITOR OF THE ELECTRICIAN.

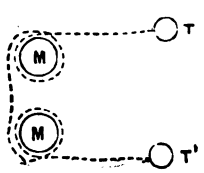
SIR: Having noticed that one of your correspondents asks (in to day's issue of your paper) where he can obtain a pocket accumulator with scarf pin, permit me to enclose you my price list for these. I may mention I am supplying some electrical effects for Mr. Augustus Harris's pantomime at Drury Lane Theatre.—Yours, &c., H. BURY.

27, Arcade chambers, St. Mary's Gate,
Manchester, Dec. 20, 1884.

WINDING FIELD MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: All the text-books on electricity that I have read, as well as those treating of dynamos from a theoretical point of view, differ from those books which treat of the dynamo practically as to the method of winding the F.M. coils, the former stating that the wire must make an **S** curve in going from one arm of the magnet to the other, whilst the practical treatises show that, looking at the magnet from the poles, the wire is wound the same way round on both arms thus :—



at the same time marking the poles N. and S.

Will you please inform me through your valuable journal—first, the practical advantage of one method over the other; and second, how the latter method is consistent with Ampère's "Memoria Technica."

I may perhaps mention that both these methods are shown in *The Electrician* present volume—the former in page 270, Fig. 1, page 280, Fig. 4, and page 364, Fig. 22; and the latter method in page 255, Figs. 4, 5, and 6.—Yours, &c.,

A STUDENT.

December 18th, 1884.

REDUCTION IN TELEGRAPH TARIFFS.—The telegraph companies to Australia, in conjunction with the Indian Telegraph Administration, have almost arrived at an understanding for an agreement reducing the charges for Press messages to Australia to a quarter of the present rates, in consideration of the Press guaranteeing a certain amount of revenue. A similar arrangement with reference to Indian Press messages is under consideration.

LITERATURE

Magneto-Electric and Dynamo Electric Machines. By Dr H. SCHELLEN. Translated from the 3rd German Edition by N. S. Keith and P. Heymann, Ph.D., with Additions and Notes by N. S. Keith. Vol. I., with 353 Illustrations. [New York: D. Van Nostrand. 1884.]

A short time since we gave a first notice of Professor S. P. Thompson's work on dynamo-electric machinery. The work now before us traverses somewhat the same ground as that of Professor Thompson's, so that we are getting rapid additions to this class of literary production. We have no intention of comparing these works, because it seems to us that the authors had not exactly the same object in view.

Let us in the first place bear testimony to the care of the editors, and direct special attention to the additions of Mr. Keith. These additions in almost every case are as valuable, and in some cases more so, than the original text. The translators have one paragraph in their preface which should be studied by all visitors to the Patent Office. They say:—"A change of a screw here, a shaft there, an alteration of field-magnets, a long or a short armature, in endless variety, does not make a new machine, though a new name may be given it."

Before describing the various machines, the elementary principles of magnetism and electricity are discussed and explained. In the first part we have the usual diagrams illustrating the direction of the lines of force in bar magnets, the solenoid and the Ampèrean theory, followed by paragraphs upon induction and the action of currents and magnets upon currents and magnets. The next chapter describes the best known form of dynamometer, galvanometer, meter, &c. We never lose an opportunity of declaiming against the lack of an acknowledged universal notation, and this chapter gives us an example, thus:—

$$A = \frac{\text{volts} \times \text{amperes}}{735{\cdot}7}, \text{ or } \text{H.P.} = \frac{\text{volts} \times \text{amperes}}{C}.$$

In the first expression A stands for horse-power, in the second C stands for a constant. Why should C in electrical formulæ now indicate current, now capacity, and now a constant? A couple of pages further the same letters are used to indicate something else, and we have I indicating current as in $I = C\sqrt{A}$, while two pages further C is used to indicate current in $E = R \times C$.

We now come to the most important part of the work, viz., those chapters describing the various machines. Part III., or, as we should call it Chapter III., deals with magneto machines from Pixii to De Meritens. Of this chapter and of the following chapters there is not much for us to say. Most of the machines have been described scores of times, but we do not think any better descriptions will be found. The interpolations of Mr. Keith are often interesting—historically as well as practically. We do not remember to have seen anywhere set forth more clearly the claims of the early workers in the dynamo field. The papers of W. Siemens in the February number of *Poggendorff*, 1867; of C. W. Siemens to the Royal Society, Feb. 4, 1867; of C. Wheatstone to the Royal Society, Feb. 14, 1867, so often referred to in the history of the development of the dynamo are here given, as is a letter from Professor M. G. Farmer, and an extract from the *Proceedings* of the Literary and Philosophical Society. Further on we have a full translation of Dr. Pacinotti's paper in "Il Nuovo Cimento," July, 1864. This portion of the work is entirely due to Mr. Keith, and he deserves our warmest thanks for printing these papers.

We have said the descriptions of machines are good; the same may be said of the illustrations.

The theory of dynamo-electric machines forms the concluding part of the book. The works of Frölich, Deprez, Thomson, Ayrton and Perry and others, form the basis of this part.

The Disc: A Prophetic Reflection. By E. A. ROBINSON and G. A. WALL. [London: Griffith, Farran, and Co., 1884.]

The internal evidence savours strongly of an American origin for this book, and still more strongly of ignorance

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regarding the fundamental laws of science. Here is the tale :— Two college chums meet after some years' separation. One knows an inventor whose secrets in the hands of the other may lead to wealth. The inventor, wedded to science, so managed that his wife ran away, leaving a daughter to the tender mercies of the scientific recluse. The daughter, however, takes after the father, and so far all is well. John Alder, the inventor, meets the two friends, shows a wonderful discovery, by means of which light, sound, and heaven knows what may be transmitted by electricity, the apparatus consisting of a "disc," wires, and other electrical paraphernalia. Sunshine can be thus transmitted, then we have a wonderful light from some chemical plastered upon the wall, and so on. A joint stock company is formed to promote and work the photo-electrophone, which proves very successful. The old inventor has steadily refused to leave his shell or take part in business matters, all being left to the two young men, who are pledged to keep his home a secret. A new man appears upon the scene with a wife and handsome daughter. One of the chums has already bespoke the daughter of the inventor, the other does as much for the new introduction. The new man is elected a director and becomes an active worker. The inventor is perfecting another invention to eliminate disease and restore youth. His experiments are seen through the photo-electrophone by his daughter's betrothed and also by the new director. The latter recognises the inventor, who is in reality the true husband. Of course the situation is now fairly startling; but the inventor is killed off, his secret for the renovation of youth dies with him, marriages are made, and all is happiness. The photo-electrophone is a grand success. Those who think this sketch interesting had better get the book, it may while away a winter's evening, though a word of caution might be given to consider the novelist's ideas as pure invention, founded upon no scientific truths, nor to be regarded as possible or probable in the manner indicated. What science may have in store for us we do not know, but at present we draw a line at bottling up sunshine in America or in Asia and electrically transmitting it to light up Lombard-street and the Poultry.

LUMINOUS PHENOMENA OF ELECTROLYSIS.

If acidulated water be electrolysed by an intense current—1 to 5 amp.—with the aid of two platinum wire electrodes, and the circuit be closed by slightly immersing the cathode, a greenish light will appear at the cathode, an energetic disengagement of gas ensue, the platinum and the liquid become heated, and the force of the current diminish considerably. If the current be rendered sufficiently intense, the noise will suddenly cease, the light become stronger, and the liquid assumes a spheroidal state, leaving the cathode, and forming round it a kind of funnel.

During the continuance of this phenomenon, gas will be disengaged normally at the anode; but, if the immersed surface be diminished, the action will be reversed, provided the current be sufficiently intense. The Russian *savan*, Slouginoff, has inquired into the conditions which determine the production of this kind of abnormal electrolysis, its causes and effects, and arrives at the following conclusion :—When the platinum of the cathode has closed the circuit by its contact with the liquid, the elevation of temperature at the point of contact may become sufficiently great to evaporate the nearest particles of the liquid in such a manner as to again interrupt the circuit. The extra current increases the effect which is reproduced the following second, when the liquid, thrown off by the vapour generated, again comes in contact with the cathode, in such a way that the intermittences of the current are repeated indefinitely. A greater intensity of current produces a truly stable spheroidal condition. This explanation is borne out by a series of facts, ascertained by experiments, of which the following are the principal. A telephone, placed in one branch of the principal circuit, or in the secondary circuit of a Ruhmkorff coil introduced into the principal circuit, causes a more or less loud sound during the abnormal, energetic electrolysis; but this sound becomes scarcely perceptible while the spheroidal state continues. The introduction of a coil into the main circuit, and also that of an iron core into this coil, increases the intensity of the sound, while at the same time lowering the note; and the extra currents, intensified by the coil, permit of the phenomena taking place with a less number of elements. Kœnig's revolving mirror decomposes the light of the electrode into a series of sparks, the configuration of the image showing that the sparks succeed one another round the electrode along a trajectory in the form of a spiral. The luminous electrode is quickly disaggregated, the liquid after the experiment containing a black powder, which is found to be platinum black. The spectrum of the light from the cathode is continuous; and in the case of very intense extra currents a few platinum lines and traces of the hydrogen spectrum may be seen.

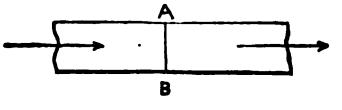
If a solution of chloride of platinum, gold, or silver (in the hydrochloric acid) be adopted for the electrolyte, a very vivid light is obtained, produced by the incandescence of the powder from the reduced metal, which, after the experiment, is found suspended in the liquid.

THE HALL EFFECT.

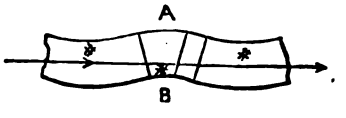
The following is Mr. Edwin H. Hall's paper, with discussion thereon, read before the American Association in Philadelphia during September :—

On the Magnetic Rotation of the Equipotential Lines of Electric Currents in Various Metal and Alloys.

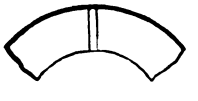
New interest has probably been awakened in the discussion of an alleged phenomenon by the objections which have been made during the last six months by one or two gentlemen in England, notably Mr. Bidwell, who has attempted to explain by the effect of strain and thermal currents the phenomenon which for the last three years has been considered a new manifestation of electrical effect. I think it worth while to give a sketch of Mr. Bidwell's explanation of the phenomenon. If this is a strip of metal through which a current is passing in the direction of the arrow, the strip will be crossed by equipotential lines as A B.



If now a magnetic force is produced, acting perpendicular to the plane of the strip, it is subjected to a strain, which forces it into this condition :



In the marked portions, the compound action of the magnetic force and the electric current tends to lift the magnetic field. The portions not marked are relatively stretched with respect to the others. I do not stop to discuss whether this strain exists. If it does occur, Mr. Bidwell says this will take place. The compressed copper is thermo-electrically negative with respect to the stretched copper, so that as the current passes across from the compressed portion to the stretched portion there will be a heating effect; and as it passes from the stretched to the compressed portion there will be a cooling effect; so that we shall have here at the top, first heat and then cold, and at the bottom first cold and then heat. The effect is to shove the two equipotential points A and B, to make this point practically nearer this end of the plate and this point practically nearer the other end of the plate.



To meet this I change the conditions of the experiment. Instead of fastening rigidly to a strip, I simply took a strip of steel and arranged it so that I could clamp it at the ends, or across the centre, leaving the ends free. Now, if in the first experiment the tendency of the magnetic action were to lift the plate, when we have the clamp in the centre, we should expect it to be forced in something like this condition by a similar action; that is, an action which would tend to lift the whole plate.

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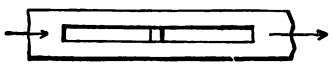
Trying that experiment with the clamp at the centre and again at the ends, I found the result to be the same whatever the position of the clamp, and the equipotential lines to have the same direction as when the plate is imbedded in a firm piece of cement.

In my first publications upon this matter I did not state whether the magnitude of the effect was the same when the plate was clamped at the middle or ends; my experiments were too rough to determine that. They appeared to be of the same magnitude. I have since compared a plate of steel, clamped at the middle only with a similar plate of steel imbedded in cement. Under these conditions I think we should expect, under Mr. Bidwell's explanation of the phenomenon, that the effect would be seriously modified, if not in direction, at least in magnitude. I did not find any such modification as that. My experiments were not accurate enough to enable me to say that the effect was absolutely the same when I was using the clamped plate as when I was using the plate imbedded in cement; but it does not vary more than ·1 per cent., if it varies at all.

There is another experiment which Mr. Bidwell has published, which seems to be of considerable interest, and to require an explanation from me. It is what he calls a reversal of this effect. He does not obtain it in any simple way, as I think he should obtain it if his theory is correct, by clamping the plate at one place or another, and so change the strain; but he gets what he calls a reversal of the effect in this way:—



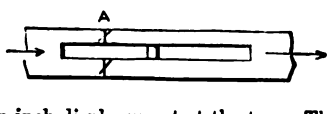
He makes a plate with a slit in it, and a narrow piece of gold making connection across the slit.

He connects the equipotential points with a galvanometor, tests as before, and finds that the effect upon those two points is not so great as before this slit was made. This, he says, is contrary to the explanation that had been given before of the phenomenon.

I wish to say just here that I do not know that any one has a right to talk of the "supposed explanation" that I have given. I have not seriously attempted any explanation of the phenomenon. I have simply stated the fact that the equipotential lines are turned in that direction by the magnetic action, instead of running straight across.

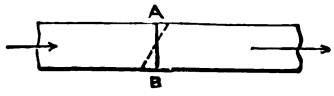
When Mr. Bidwell connects a point there with a point there (indicating) he gets an upward current, and that, he says, is a reversal of the effect.

This strip is practically two strips, connected by this little arch. In fact Mr. Bidwell himself stated that it would be so. Remember that all I claim is that the equipotential lines are rotated to a certain extent from the vertical. With a given magnetic force and given intensity of current passing through the strip, the upper line will be rotated about its centre,



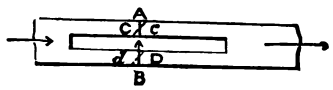
so as to give, say, an inch displacement at the top. The other line below will be rotated through an equal angle about its centre, and the displacement of its lower point would be one inch.

Let us take the entire piece, with no slit in it. We have the points A B, as before, and the line joining them is rotated through the same



angle that the shorter lines A C, B D were rotated through, and we get practically a displacement of two inches. We should therefore expect the effect to be about twice as great in this case as in that.

What would be the effect if we bridge this slit? It would not entirely restore the condition of the whole plate. Suppose—this slit remaining unbroken—you were to connect a point there *c* with a point down there *d*. This point *d*, being at the left of that line B D, means that it is at a



higher potential than any point on that line, and this point *c* being at the right of that line C A, means that it is at a lower potential than any point on that line. But these two lines B D, C A being equipotential lines, the consequence is that this point *d* is at a higher potential than that point *c*, and the current, flowing always from the higher to the lower potential, will be in this direction, *d c*. Putting in a narrow bridge will not entirely destroy that effect. That, I think, is a sufficient explanation of what seemed a very damaging experiment by Mr. Bidwell.

The new points which I have obtained with reference to this matter are not very startling, and, as they will appear in print before long, I shall not discuss them.

However, with reference to the effects of temperature, in all magnetic materials (whether the effect in them be positive or negative) the effect of a rise of temperature is to increase the transverse effect. Mr. Tomlinson has discovered relations from which he predicted that in nickel the angle of transverse effect should decrease with rise of temperature, and he questioned my conclusions in regard to that matter, saying that my experiments were not entirely satisfactory. I agreed with him, and so I repeated the experiment this summer with considerable pains, and the conclusion is the same as before. The effect in nickel is decidedly to increase the transverse effect about 2-3rds per cent. for a rise of one degree between 23, 24 and 24, 25. There is also a considerable numerical increase in the transverse effect with iron, steel, and cobalt. With respect to the non-magnetic metals, although I cannot speak with certainty with respect to any of them, it appears that an increase of temperature gives a slight decrease in the transverse effect. There is only one apparent exception—one of the alloys of copper and zinc.

Sir William Thomson: When I first heard of Mr. Hall's discovery it appeared to me to be a discovery of a most important phenomenon, in fact one of the most important discoveries of this century in respect to magnetism. The phenomenon belongs to the general class of rotational phenomena the theory of which falls under the very general subject in dynamics of gyrostatics. Mr. Hall's discovery interested me particularly, as it brought out in fact a result that had lurked in mathematical formulæ from about the year 1856, if I remember right. In a reprint, which appeared about a year ago, of a paper on "The Electro-dynamic Energies of Metals", and of another on thermo-dynamics, published respectively in the *Memoirs* of the Royal Societies of London and Edinburgh, I called attention to the fact that now Professor Hall had demonstrated by experiment the result which lay there in those formulæ, and which was referred to there as a thing to be looked for by experiment, the thing had been pronounced, even by so great an authority as Professor Stokes, to be improbable, because it was so unlike what we know of the general properties of matter. Still, it seemed to me that the dynamical foundation in the essential properties of energy connected with magnetism being there, we must not, because it seems unlike what we know of the distribution of heat through crystals and such other phenomena, therefore assume that it was non-existent. I did, in fact, myself make an exceedingly slight and unsatisfactory attempt to obtain the result. I obtained no conclusion whatever, but left the thing as I found it, demonstrated as a proper mathematical result of magnetic influences, but not yet discovered by experiment. It was therefore to me that the matter was of exceedingly great interest when I found it was discovered by Professor Hall.

The explanation which Mr. Hall has given of Mr. Bidwell's ingenious last attempt to disprove the result is very interesting, and we see that Mr. Bidwell's attempt to explain away the phenomenon is only curious, and not in any sense important. It struck me that there was another way than that which Mr. Hall put before us of making a crucial experiment to test whether or not there was anything in the kind of action indicated by Mr. Bidwell. The experiment might have been made in this way: take a strip of material and apply independently a mechanical strain, which may be made without disturbance of the electrical balance, and to be made much greater than the strain invoked by Mr. Bidwell for explanation. Has or has not Mr. Bidwell's attempted explanation been tested by applying a mechanical force pulling to one side? That should give a far greater result than the very small magnetic stress assumed by Bidwell.

Professor Silvanus P. Thompson: I think the experiment was tried by Mr. Bidwell with success. I am not positive about that, but I believe that was the case. I do not know how great a force he applied.

Sir William Thomson: It is quite clear that Mr. Bidwell's suggestion is apposite to the thing. It is the suggestion of a thing that would produce the effect that Hall has discovered. It is itself founded on the gyrostatic property that transverse force which we know to exist will induce qualities which indirectly will have an effect upon Hall's result. So, though I have spoken somewhat slightingly, perhaps, of Mr. Bidwell's suggestion, I do not wish to do so altogether. It is very ingenious. I would think it worth while to go into an examination of the kind of action involved in Mr. Bidwell's suggestion and compare that with the magnitude of Hall's action. Mr. Bidwell's explanation would make it a matter of time. It would be some time before the metal becomes heated; whereas it seems that the property may be an instantaneous one connected with the instantaneous existence or non-existence of the force.

Mr. Hall: Yes, sir. And not only that, but it would depend very greatly upon the surface condition of the metal; for example, whether the strip was exposed to the air, or imbedded in the resin and beeswax. My experiments also show a very great range of conditions as to the temperature, with no corresponding change to be observed in the effect.

Sir Wm. Thomson: It seems, in fact, that Hall's statement, that he has experimented with a variable clamp and observed no difference, is quite decisive against Mr. Bidwell's theory. Let me point out a mechanical model of Hall's phenomenon. It is very far from fitting exactly, but that it does contain the essential, fundamental principle of Hall's phenomenon I cannot doubt. Let us suppose you have here a circular canal of water on a turning table which may be going around once in five or ten seconds. Suppose we have a large turning table so that it could be done. It would not be of the slightest value to do it, yet it is interesting to feel that the conditions are realisable. Suppose we had a turning table five yards in diameter, going around once in three or four seconds; and suppose here is a water trough around it, filled with water.

Stand up and look at this water in the trough; it is completely at a level with the motion of the table, but the outside is a little higher than the inside, in consequence of centrifugal force. Take that as the datum from which we measure all our constructions. Let one part of the canal be taken up by a pump. That is an arrangement for causing water to flow, and corresponds precisely to the voltaic battery. Cause water to flow around, and there will be disturbances and oscillations corresponding to the oscillations of the electric circuit before it settles down to the work imposed on it by the voltaic battery. Suppose, first, the water to be forced in the direction in which the table is turning. It will increase the effect of centrifugal force and cause the water to stand higher still on the outside than on the inside. Looking at the level or applying a test of levels, we have Mr. Hall's wire electrodes for testing the difference of potentials on the two sides of his strip. The pump is

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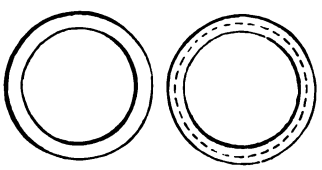
stopped, the water settles again, and then water is pumped through in the opposite direction. It is now found that the level rises on the inside, and falls on the outside. Here is the fundamental dynamical analogue—I believe ultimate explanation, but I only venture to say analogue now—for Mr. Hall's phenomenon.

Now for Mr. Bidwell's ingenious last experiment, which is really very interesting as interpreted to us by Mr. Hall. Suppose we put in a barrier quite around here. That will give us two canals instead of one.

Everything remains the same until there is a current through the canals, and then we have the difference of potentials indicated by Mr. Hall. But make a hole in this barrier, which correspondends to the bridge across the slit of the metal strip. There will be a flow around the canal, and a continued flow through this little hole in the barrier. Suppose, for instance, the motion of the water to be in the same direction as the motion of the turning table. At a considerable distance from the place where the barrier has a hole in it we should have a higher level on the outside of the outer canal, a lower level on the inside ; a higher level on the outside of the inner canal, a lower level on the inside. That state of things would exist up nearly to the hole of the barrier. At the hole in



the barrier there will be a continued flow of water through, in virtue of the level being higher here and lower here than the average. That state of things exists a little distance on each side of the hole, and if the hole be small in comparison with the size of the canal, the result will be a point, P, near the hole on the inside, which, notwithstanding the hole is there, will share the higher level that exists all around the outside of the inner canal, and a point, Q, near the hole on the outside will share the lower level of the inside of the outer canal. Thus we have the complete hydraulic analogue, both for the fundamental phenomenon and for that curious illustration of it with which Mr. Bidwell attempts to disprove it.

Professor Silvanus Thompson : If I have any criticisms to make on what Hall has said, it will be directed to two points on which experiment can be further brought to bear. In the first place, when you had those two metal strips, clamped in the one case at the ends, in the other at the middle, I think you told us those strips were made of steel. Did you try any other metal than steel ?

Mr. Hall : I did not.

Professor Thompson : What was the size of the magnetic pole-piece that you applied in front and behind the strip ?

Mr. Hall : Perhaps 3·5 centimetres in diameter. The strips in which I used the clamp were entirely within the poles—about 3 centimetres long and 1 centimetre wide.

Professor Thompson : In my experiments I was very particular to employ very large pole pieces that very much more than covered the strips, and then again, pole-pieces which covered only portions of the strip, and I found the effects to be different in the two cases. If you have a strip with a current running through it and placed in a uniform magnetic field, it will not be bent up at the middle as compared with the edges. There will be no bending of this kind, because the whole strip will tend to lift uniformly. But, in the first place, if you are working with a pole-piece that considerably exceeds the size of your strip, you have not got the uniform field, and the mechanical sidewise thrust is greatest where the field is strongest. There will be a greater thrust at the ends than at the middle, which will have the same effect as if the strip were clamped at the middle, and you would have the same effect whether the strip were clamped at the ends or the middle.

Again, taking the size of strip shown us here, suppose you were to warm one edge 5° centigrade. There will be a slight depression toward the other side with those clamps, which would certainly admit of an increase of movement. Therefore I cannot accept those clamps as being sufficient to prevent the existence of the Bidwell effect.

My next point of criticism is as to the diagram which we had of the equipotential lines when Mr. Bidwell's alleged reversal of the effect was so well explained to us by Mr. Hall. You had the slit, and the bridge across it, and I followed every point except one ; I do not understand when you have a continuous metallic surface how you can have equipotential lines ending on the strip, here and there (indicating) ; it must somehow get across from this strip to that.

Again, I think that the fact that no Bidwell effect was observed by Mr. Hall in those steel strips may be due to the fact that they were of steel, and that with some more magnetic metal, such as gold or tinfoil, the Bidwell reversal might have been obtained.

Lastly, I have very carefully examined that on which the whole thing rests—the position of the equipotential lines. At the meeting of the British Association three years ago, when I took exception to certain points of Hall's explanation, I ventured to suggest, although I had not tried the experiment, that although one portion of the lines might be twisted out of the perpendicular, you did not have the lines, as a whole, twisted out of the perpendicular, and that it was an internal effect either of stress or change of electrical resistance. I had the equipotential lines something as I have drawn them here, and I remember, while I was talking, Sir William Thomson went to my diagram and crossed it out, saying, "No, no, here is how the equipotential lines must go."

With the most delicate galvanometer I could use I have carefully examined the equipotential lines. The strip of tinfoil which I took was 10 centimetres wide and 30 centimetres long, fastened with brass clamps at the two ends. When there was no magnetic field the equipotential lines ran beautifully straight across. But when we applied a magnetic force by pointed magnetic poles, placed in front and behind the strip, on making a careful exploration we found that a little before and behind the magnetised point those lines bowed out as if there had been an increase of electrical resistance in that part of the foil. We proved it afterwards by putting strips of foil in a magnetic field and measuring the increase of electrical resistance, which proved to be a little over 1 per cent. We never could find the right plotting of the magnetic lines ; we only found certain curvatures, which could be entirely explained by electrical resistance.

I would ask Mr. Hall whether he has found that these equipotential lines are twisted all along the magnetic field in the manner in which his theory supposes they are.

Mr. Hall : It was settled, once for all, that they did run in that direction ; they ran slantingly through the whole length of the strip. That was the question at issue between Professor Rowland and myself. It was the opinion of one of us that the lines would be bowed at the ends. I called in another gentleman to witness that particular experiment, and before I tried it I predicted what I thought would occur. These lines ran slanting the whole length of the strip, which was of gold.

I cannot say what effect you would have when you have a small pole acting over a large strip of metal. I would suppose, however, you would not get any particular effect at the edge ; it would simply be a rotary magnetic effect.

There is another point that I did not mention this morning. Suppose we have a certain magnetic force, m, and a certain strength of current, C. We get a certain rotational effect from that, due, as Mr. Bidwell says, to a strain produced by the action of the magnet upon the current, and that strain reacting upon the current in the way we have discussed. We can double that strain in various ways. One way is to make the magnetic force $= 2m$. The force being doubled, the strain should be doubled, and we should suppose that the effect would be twice as great. But suppose we double the strain by doubling the current, then the strain will not only be twice as great, but the current flowing through this strip will produce twice the reacting effect. In other words, doubling the current should produce four times as great an effect as before. I do not find it so. In whatever way I produce the strain, by increasing the current or the magnetic force, the rotational effect is simply proportional to the strain.

It is evident the effect could not be proportional to the strain if it were produced by a reaction of the strain upon the current, because it is impossible to conceive of a case in which a given strain would not produce a greater electrical disturbance on the equipotential points when there was a current two flowing through the strip than when there was a current one flowing through it. There is evidently an intimate relation between the properties of metals, as I have studied them, and their properties under certain electrical conditions.

Professor Ball : When Mr. Bidwell's suggested explanation, by tension, &c., was made, it appeared to me only in the light of a plausible and ingenious way of getting at the other explanation. I so expressed myself to Mr. Bidwell, and he invited me to come and see his experiments ; and there was one thing which struck me, and that is the necessity of his theory and the foundation of it, viz., that the order of the different metals, whether positive or negative, in connection with the Hall effect, is exactly the same as the order in which they lie in respect to their thermo-electric properties when under strain. I saw Mr. Bidwell's experiments, and there was not the slightest doubt about it that in every case the metal which showed a thermo-electric effect in one direction showed a Hall effect in the same direction. It may be that Mr. Hall's casual remark just before he sat down, that there is evidently a connection between the thermal effects and the Hall effect, is all we can say ; and I think the final result will be that the Hall effect and the thermo electric effect both depend upon some peculiar condition of the metal, and that the one is not directly dependent upon the other.

Mr. W. H. Preece : I merely want to call Mr. Hall's attention to one inquiry that Mr. Bidwell has made. The essential feature is this : Whether there is contraction and dilation of the molecules on each side of the plate ? If you replace your steel or gold plate by a thin sheet of mercury, then the molecules, having free play among themselves, ought to indicate the condition of compression or relaxation. Mr. Bidwell has done this, and you will find the moment you make your contact and the current flows, all the mercury flies off, excepting little currents which rotate about in the most beautiful manner, and give you a proof that there is certainly dilation of molecules in respect to Mr. Hall's process.—*Electrical World.*

PHYSICAL SOCIETY.—Dec. 13.

Professor Guthrie, President, in the chair.

The following communications were read :—"On the Effect of an Electrical Current on the Rate of Thining of a Liquid Film," by Professors A. W. Reinold, F.R.S., and A. W. Rücker, F.R.S., read by Professor Reinold. In 1877 the authors communicated to the Royal Society an account of some experiments upon the electrical resistance of liquid films. The results then obtained showed that there was some disturbing influence present, and the authors now find this to be the action of the current upon the film itself. The films experimented on were, as in the original experiments, cylindrical and vertical, formed upon two coaxial platinum rings which are the electrodes by which an electric current can enter and leave the film. The mode of formation of these films and the precautions necessary to keep them from gaining or losing moisture by condensation or evaporation have been already described before the Royal Society. [*Phil. Trans.*, 1881, Pt. II.]

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When such a film just formed is left to itself, it shows a set of colours of different orders arranged in horizontal bands. As it thins under the action of gravity these bands gradually broaden out and descend, a black band soon appears at the top, which likewise extends downwards. If a current is now passed downwards through the film the motion of the colour bands is accelerated, showing that the effect of the current is to assist gravity in thinning the film; the black band, however, becomes in part or entirely white. This upon examination is found to be due to the following action: the film is not directly dependent upon the upper ring, but is attached to it by a comparatively thick mass of liquid. The action of the current is to transfer liquid in its own direction, thus, like gravity, thinning the film. The mass of liquid, however, on which the film hangs by this same action is forced down into the black portion, which consequently becomes white. If the current be passed upwards the reverse effects occur; the downward motion of the bands is retarded, or, with a strong current, reversed. The explanation is precisely the same as before; the liquid is transferred along the film in the direction of the positive current; it sometimes collects in the form of pendant drops attached to the upper ring; these increase in size, and stream down the sides of the film. Professor Reinold then formed a plane film between two horizontal wires. The film was illuminated by the lime light, and its image projected upon a screen. The motion of the bands of colour in the direction of the current produced by 50 Grove cells was clearly shown.

In a discussion which followed upon the transference of matter with the current, Professor Ayrton described some experiments recently made by Professor Perry and himself, which showed that certain metals were carried through mercury in the direction of the current.

Mr. Boys remarked upon the apparent inertia of the film; the current seemed to require time to develop its action, no motion of the colour-rings being visible for some seconds after making the current.

Dr. Stone exhibited a tuning-fork interruptor commutator. This is an instrument for reversing an electric current through a circuit a given number of times per second. From the free end of a spring kept vibrating in unison with an electrically maintained fork by an electro-magnet in the circuit of the fork acting upon an iron armature attached to the spring project two small aluminium plates, side by side, but insulated by ebonite from the spring and from each other. These are connected by fine wires which do not interfere with the vibration of the spring to screws upon the base of the instrument to which the poles of a battery are joined. The motion of each plate is arrested upwards and downwards by aluminium stops, so that there are four such stops arranged at the corner of a rectangle. They are connected in pairs, diagonally, and each pair is in communication with one end of the external circuit. Thus, when the spring is up, the current flows to the aluminium plates, and is transmitted through the circuit in one direction. When the spring is down it flows by the lower stops in the opposite direction. The electromotive force is thus reversed in the circuit twice as many times as the fork vibrates per second.

Mr. Lewis Wright exhibited his new oxy-hydrogen lantern microscope. Details of this instrument will shortly be published. Geological, medical, and biological specimens were exhibited upon the screen with great distinctness, the definition being singularly perfect under the highest powers.

COMPANIES' MEETINGS.

Anglo-American Brush Electric Light Company.

An extraordinary general meeting of the shareholders of this Company was held at the offices of the Company, 112, Belvedere-road, Lambeth, on Monday last, Mr. J. S. Sellon presiding.

The SECRETARY (Mr. E. Garcke), having read the notice convening the meeting,

The CHAIRMAN, having expressed his regret that the President of the Company was unable to be present at the meeting through a pressure of engagements in the North of Scotland, went on to say that the subject for the consideration of the shareholders was of so simple and straightforward a nature, and had been so thoroughly dealt with in the circulars which had been received by them, that he felt any lengthened remarks he might offer would unnecessarily take up their time. He therefore proposed to answer any questions it might please gentlemen to ask, rather than to go over ground which had already been fully explained. He would ask them to accept as a matter of course the fact that their Directors had very fully considered the bearing of the proposed amalgamation, or rather he should say absorption of the interests of the Great Western and Midland Companies. And he would also ask them to accept as a matter of trust the policy which they had laid down. The time which had elapsed since the formation of these sub-companies had been sufficient to prove that, to a greater or less extent, the expectations which had led up to their existence had not been fulfilled. Many things had combined against that—amongst others the slow recognition on the part of the public of the value and advantages of the electric light; the disastrous attempts at legislation, which had without doubt up to the present time throttled a great and scientific industry, and which had almost taken the heart out of those, or some of those, who had earnestly engaged in the great work; and, in some measure, no doubt, the speculative spirit which at one time pervaded the community, and which brought about a natural reaction. All these elements combined had been against the success of the electric light; and so, too, as must be the case with every new scientific development, few persons at the commencement were sufficiently acquainted with the difficulties that beset it; and, altogether, a business which, under good management, could not fail eventually to be a success had been kept back by these obstacles. It was very easy to moralise on the past, but they had to look forward to the future, and in the future there was, he thought, very great hopes of the success which at one time was desired. With regard to the amalgamation it was considered by the Directors that concentration of energy and uniformity of plan and management were essential parts of such an organised system of work throughout the country as they desired to bring about, and in order to be able to carry out their policy it was necessary that they should have free hands throughout the country, and be untrammelled by reports which were friendly or otherwise, and which seriously interfered with their independent action. He would now only detain them by briefly summarising the effect of the proposed step as far as capital account was concerned, if it should meet with their sanction. And he might mention incidentally that if he were to judge from the very large number of proxies they had received the course they recommended appeared to meet with unanimous approval, for they had nearly 30,000 proxies. As explained in the statement before the meeting, the total number of shares which it was proposed to issue to the two Companies amounted to the value of £33,475. For this they received plant, installations, land, buildings, and stock, fairly estimated as being worth to the Company about £16,750; cash, about £7,700; unpaid calls to collect, £4,100—leaving a deficit, as against the nominal share issue, of £5,000, against which they received back the licenses and secured the goodwill of the 23 counties at present out of their control. He could assure them that the very careful consideration of the Directors had been given to these provisional settlements. He would also like to pay a tribute to the care and business-like treatment which had been paid to the negotiations by the Directors of the Great Western and Midland Companies. The Board could confidently recommend the acceptance of the agreements as now offered; and, if it were the pleasure of the shareholders that they should be accepted, the Directors had no doubt that the ultimate result would be one of satisfaction to them as well as to the shareholders of the two sub-companies whom they would then have to welcome amongst themselves. He commended to their judgment, and he hoped to their approval, the resolution which had been read by the Secretary, and which he would now formally move:—"That the Provisional Agreements entered into between the Corporation and the Great Western Electric Light and Power Company (Limited), and the Brush Midland Electric Light and Power Company (Limited and Reduced), dated respectively 28th November, 1884, and 29th November, 1884, and submitted to the meeting, be and the same are hereby sanctioned, adopted, and confirmed, and that the Directors be authorised to carry the same into effect respectively, with or without modifications, and for that purpose to enter into and execute all necessary deeds and documents, and to issue not exceeding 6,695 fully paid £5 shares in the capital of the Corporation, such shares to be numbered from 40,701."

Mr. GIBBS seconded the motion.

Mr. MEYER wished to know why this meeting should have been called for the 22nd December, when, in the ordinary course of affairs, in two or three weeks' time, the shareholders would have been informed by the annual report and accounts of the state of their affairs, and been better able to judge as to whether or not the purchase was likely to be advantageous for the Company. He wanted to know also upon what footing the purchase-money had been calculated, and went on to show that, according to the quotations on the Stock Exchange of the shares of the various companies, the purchase-money was not founded upon the relative value of those shares in the market, especially at the time when negotiations were commenced with a view to bringing about the proposed amalgamation. He could not help thinking that the result of the scheme now projected had been to raise the price of the Great Western and Midland Company's property not quite on its merits, and questioned whether the Corporation were not having the worst of the bargain. He suggested to the meeting whether it would not, under these circumstances, and in the absence of the annual report and accounts, be better to adjourn the meeting until the latter should be placed in the hands of the shareholders.

The CHAIRMAN, in reply, said that the Directors of the Company entirely ignored the Stock Exchange or any of the prices that might be quoted there with regard to one Company or another. That had nothing at all to do with the conclusion they had endeavoured to arrive at, namely, a satisfactory arrangement with those two Companies, in order, as he had said, to carry out the policy which they had laid down. It was very possible that some weeks or months ago shares might have been bought in both the Great Western and Midland Companies at a very much less figure than the value arrived at in the course of their negotiations. Calculations upon Stock Exchange rates were not to be relied upon in cases of that kind, because those rates were continually fluctuating. The Board had followed one course. They had endeavoured to arrive at the assets of those Companies as they stood, and they had ascertained to the best of their judgment the value which the absorption of the Great Western and Midland Companies could be estimated at in enabling the Board to carry out their intended policy. As he had stated in his former remarks, the expectations that had been formed of those sub-companies had not been fulfilled, which accounted probably for the low price to which the shares had dwindled. But the moment there was a value given to anything in the world of course its importance increased, and they had been obliged, therefore, to deal with the companies in question upon what he said was a fair and equitable basis. He was quite sure that those who could examine the accounts as the Board had done would be quite satisfied with the result that they had arrived at. The absolute summary of the scheme would be this: that the Brush Company would receive in cash about £7,700, and the calls due to the Midland Company, which were £4,100, and they had good reason to suppose that the bulk of that money would come in; and if it did not come in, of course there would be no issue of shares to the extent of the amount unpaid. Therefore the Com-

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pany was quite protected so far as that was concerned. The way in which the value of the plant, installations, land, and buildings was arrived at was a very satisfactory one for this Company, because it had been taken upon what no premium had been paid. As he had explained, however, there was a deficit of £5,000—that was to say, they had to issue about £5,000 more of fully paid shares for the goodwill and the return of the concession for the twenty-eight counties already referred to. He did not think that that sum could be grudged. He thought that the shareholders of the companies to be absorbed might perhaps say that it was the minimum value which was given. At any rate, it was one which commended itself to the judgment of the Directors, whom the shareholders must either trust or mistrust. If they trusted the Board the latter would be very glad to work for the Company, but if they mistrusted the Directors they would be very glad to let the work fall into other hands. As to the calling of the meeting, at present he could only say that it was extremely desirable to close all these questions, so that there would be no complication in the accounts and report to be submitted to the annual meeting. It would, they thought, be a pity to bring in any complication at the general meeting which would operate prejudicially against the working of the Company. He would therefore ask Mr. Meyer to withdraw his suggestion for adjourning the meeting.

A SHAREHOLDER pointed out that the Stock Exchange quotations were the only barometer by which the value of the different companies' shares could be ganged.

The CHAIRMAN said it was an exceedingly dangerous and untrustw rthy barometer to go by.

After a few more remarks from Mr. Meyer and the Chairman bearing on the adjournment of the meeting, the former gentleman did not press his amendment, and the resolution was put to the meeting and declared carried, which concluded the business.

The Provincial Brush Electric Light and Power Company (Limited and Reduced).

The second ordinary general meeting of the shareholders of this Company was held at the Company's offices, 68A, Cow Cross-street, E.C., on Monday last, under the presidency of Mr. Thomas Fry.

The SECRETARY (Mr. Alfred Jermyn) having read the notice convening the meeting,

The CHAIRMAN said the Directors had asked the shareholders to meet on that occasion at the factory because they wished them to see how the business of the Company was being conducted under the altered conditions referred to in the report. Something had been said about the date fixed for the meeting, but the explanation was this: It was only on Saturday that the sanction of the High Court of Justice was obtained for the reduction of capital in the Company. And as regarded the place of meeting, he thought it was most desirable that the shareholders should realise the full significance of the change that had taken place in the Company's position, and to see of what importance it was to them that they had a large interest in a manufacturing company for whose accumulators and other patented inventions there was a growing demand. He need not tell the meeting that nearly all the electric lighting companies had lately fallen on very bad times. It was thought when this Company was started, with other kindred undertakings, that to obtain a concession from the Brush Company, no matter at what cost, was all that was required to lay the foundation of a profitable business. Then came the Electric Lighting Act of 1882, and it was believed if they could only secure provisional orders success was certain. Well, he need not tell them all those hopes and expectations were soon rudely shattered. They saw the Scotch Brush Company retire early from the field. Then came the collapse of the Metropolitan Company, which brought disaster on the shareholders, and also affected prejudicially the interests of all other companies. They now heard that the Great Western and the Midland Companies, not desiring any longer to walk alone, had resolved to return to the parent nest. No doubt those companies could only work under the licences that had been granted to them by the Brush Company. But the position of the Provincial Brush Company must be considered to be entirely different. They were doing business independently of the Brush Company, and were, through their association with the Consolidated Company, in possession of a system which they thought would be adopted very generally for electric lighting. Let them glance for a moment at the position of the large companies—the Brush, the Edison-Gower, the Storage, and the Maxim-Weston—and they found disclosed in the published accounts of these companies that they had all met with enormous losses in doing unprofitable work, and in addition to that they had been compelled to make immense reductions of capital upon a revelation of their assets. Looking at that state of things the shareholders might congratulate themselves on their own position. Although they had met with certain losses their position was in the main satisfacrory, because after making those losses they had now laid the foundation of a profitable business. He would refer them to the working of a system by the South Eastern Company at Colchester, because they had a like interest with the South Eastern in the adoption of the system in other places. They claimed that at Colchester an undoubted scientific and mechanical success had been achieved, and he believed that it would be followed in due time by a commercial success. Of course all the companies had been established with a view to the making of money, and it was to that object that they must direct their attention. They thought they had got over many of the preliminary difficulties, and they were now obtaining from day to day an accession of business that would be greatly to the Company's advantage. Not only did they regard the success at Colchester as a fact establishing the working of their system, but the public notice of what they had done there, or what had been by the South Eastern Company, had brought to the Company a very large amount of business. And it had come to them without solicitation from all parts of the world, amongst others from Portugal and Spain, and in the way of actual business and inquiries from India, Canada, New Zealand, Russia, Sweden, and Italy; and therefore the Board considered that, with their present working arrangements with the South Eastern Company, and with the interest they had in the Consolidated Manufacturing Company, a certain amount of business was sure to follow. As to Lisbon, the estimate given by the South Eastern Company for the installation there amounted to £32,000. A preliminary order had been received and executed to the extent of over £1,000, and so certain was the business that they found that money was lodged in the bank here which the Company drew against the shipment of their plant. This Company, he might tell the meeting, had an interest in the execution of these orders, as they were accepted on joint account, because they were both interested in the Consolidated Company, and contributed like funds to the support of that Company. They considered that, having reached this point, having since the 30th of June, when the accounts were made up, obtained the orders to which he had referred, they had now a fair prospect of doing profitable work, and they were doing it at a comparatively small cost. They knew that outside the Board an approach had been made to the Brush Company, with a view to come to some arrangement with them similar to that carried out by the Midland and Great Western Companies; but at present he could not say that there was any basis for such an agreement. The Brush Company, it was said, were ready to take over on certain terms the whole of their assets, but would that Company take over their liabilities—liabilities which had been accepted in connection with the Consolidated Company, and which they were bound, he thought, to meet? He doubted very much, if they approached the Brush Company, whether they would find that there was any basis upon which they could treat. That being so, or even supposing there was any chance of agreeing to terms, it led him to say that they could much better stand alone and continue to do their own work. In this Company there was no immediate necessity for making a call, and he might say that whenever calls were made they would be made to a very moderate extent, not exceeding 2s. 6d. a share at each time. In conclusion, he thought they had reached that point when the Directors might very fairly ask the shareholders to support them in their endeavours to carry to a successful end the business of the Company; and he therefore, with great confidence, moved the adoption of the report and accounts.

Mr. CHAS. WAPSHARE seconded the motion, and gave an account of the present position of the Consolidated Company. The shareholders, he said, would remember that at the last June meeting it had been explained that the factory would be probably too small for carrying on their operations. The Board had accordingly increased it by taking a lease of the adjoining premises, and they were now in a position to do a large amount of business, and he was glad to say that there were indications of very extensive orders coming in, out of which the Provincial Company would reap a certain benefit, as they did business constantly with the South Eastern in supplying dynamos, secondary batteries, and other plant, on which they got a large discount of 20 per cent. His principal object in addressing the meeting as to the Consolidated Company was to point out the value of the property. In doing so he wished to say that he attached the greatest importance to their secondary battery. If he was correct in the view he took—and he did not wish to be enthusiastic, because no one engaged in the electrical industry should indulge in enthusiasm to any great extent—he had no hesitation in saying that there would be most profitable returns from the sale of their secondary batteries. Having briefly recounted the merits of the battery in question, the speaker went on to say that there were daily increasing signs of the growing demand for the electric light, and the concensus of opinion went to show that it was only by storage that success could be attained. That had been the opinion of the Board all along, as the shareholders were aware, and they had never swerved from it. And had it not been for the depression of trade, and a variety of other causes which he would not dwell upon now, it would have been impossible to keep pace with the demand. Estimates were being constantly asked for, and everything seemed to go to establish the fact that the taste for electric lighting was developing, and the Company had a most promising prospect before them. The electric lighting industry was entirely new, and they must not be judged in the first two years' working, under exceptional difficulties. The Board had never been free from anxiety since they had been connected with the business, and they had spared themselves no trouble to make it a success, giving the most minute attention to all the complicated questions that had arisen from time to time. Fresh difficulties might still arise, but he had no doubt that they, too, would be overcome. Up to the 31st December, 1883, there were 78 electric light companies registered, and he believed he was correct in saying that at the present moment there were not ten that were capable of undertaking any real or useful work. The rest were moribund, or deceased. As regarded Colchester, which was the keystone to the position, he might say that doubts had been raised as to whether the B K T system was a success. He visited that town at the end of last week to see what was really the case, and he found the lights burning brilliantly, and the consumers all expressed their satisfaction with the light.

Mr. R. BRAITHWAITE moved an amendment, the effect of which was to defer the adoption of the report and accounts, to adjourning the meeting for a month, and to appoint a committee of two gentlemen to inquire into and report upon the present position of the Company.

Mr. CUMBERBACH seconded the amendment, which on being put to the meeting was declared lost.

Mr. BRAITHWAITE thereupon demanded a poll, and Mr. Burt was afterwards appointed scrutineer.

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A short and unimportant discussion followed, and the original motion was put and declared carried.

On the motion of Mr. F. G. BEST, seconded by Mr. HYDE, both the retiring Directors (Mr. R. Cunningham and Mr. Thomas Fry) were re-elected, as were also the auditors, Messrs. Price, Waterhouse, and Co., and the proceedings terminated.

Great Western Electric Light and Power Company.

An extraordinary general meeting of the shareholders in this Company was held at the offices, Great Winchester-street, E.C., on the 23rd inst., under the presidency of Mr. J. Braithwaite, jun., when the resolutions passed at the meeting on the 8th inst., confirming a provisional agreement between the Anglo-American Brush Electric Light Corporation and the Company for the amalgamation of the Companies were confirmed, on the motion of the Chairman, seconded by Mr. Stewart.

The Oriental Telephone Company (Limited).

An extraordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on the 22nd inst., under the presidency of Colonel Gouraud, in pursuance of a requisition to consider two resolutions appointing a committee of investigation and increasing the number of Directors.

The CHAIRMAN said that the Secretary would read the notice convening the meeting, immediately after which he proposed that the gentlemen in whose interests the meeting had been called should take precedence, and move the resolutions of which notice had been given. He took that perhaps somewhat unusual course in view of what he had been told, namely, that it very often happened that some time and a great deal of temper were frequently wasted in order to get this concession.

The SECRETARY (Mr. W. G. Hall) having read the notice convening the meeting,

The CHAIRMAN said it was now in order to move the resolutions.

Mr. THOMAS LLOYD stated that in the circular he had sent out to the shareholders he had briefly pointed out the chief reasons which had induced his friends and himself to act in this movement. They would remember some little time ago that a committee of investigation was appointed by the shareholders of the Consolidated Telephone Construction and Maintenance Company, and that committee reported very unfavourably about three of the four Directors.

The CHAIRMAN (interposing) said that if Mr. Lloyd was going into the report of the committee of the Consolidated Company, it would be a great deal better if the whole of the report were read.

Mr. LLOYD stated that he had no intention of dealing at length with that report, but only wished to remark to the meeting why it was that those with whom he was acting had taken the place which they had taken, and the first thing that induced them to do so was the report of the committee bringing charges of a breach of trust against certain members of the Directorate of the Consolidated Company who were also Directors of the Oriental Company—three out of the four Directors of the Oriental Company who were permanently resident in London. It had seemed to them reasonable and proper that they should inquire whether the affairs of the Oriental Company were being better managed than were the affairs of the Consolidated Company—according to the report of the committee, the correctness of which it would be understood he was not assuming. It had, however, been accepted by the Consolidated shareholders, and in consequence the members of the investigating committee were now in the places of the old Directors of the Consolidated Board. No charges, therefore, which had been brought by that committee had been accepted by the shareholders of the Consolidated Company, and it had seemed to them reasonable and proper that they should inquire whether the affairs of the Oriental Company were being better managed. They trusted that they were. He should think that the Directors against whom such very grave charges had been brought ought to welcome the proposal for investigation if everything was straight. The requisitionists had no interests adverse to the Board, and they were not in the least anxious to find them guilty in any way. In the circular which the Directors had sent out to the shareholders, they said that they had invited the shareholders of the Company individually to come to the office and make any inquiry they pleased. His (the speaker's) first answer to them, however, was that at the last meeting of the Company a consultative committee was formed consisting of three members—Mr. Pender, their late chairman; Mr. Akers, the largest shareholders in the Company; and Mr. Grewing. The majority of that committee, Messrs. Akers and Grewing, were soon convinced that a consultative committee was a farce, and that it was intended to be a farce, and that any unauthorised inquiry would do no good. Therefore Mr. Akers and Mr. Grewing were assisting the present movement of which he (the speaker) had made himself the exponent. Mr. Akers held 24,000 shares, and that being so, he thought they would agree with him that that gentleman was not likely to do anything to injure the Company. He considered that when Mr. Akers and Mr. Grewing thought that there should be a committee of inquiry that was strong *primâ facie* evidence that a committee of investigation ought to be appointed. He wished now to call attention to the report of the auditors, which the Directors had sent out with their second circular, and if they had carefully read that report they could not have failed to be struck with the extreme caution which the auditors had displayed. They were careful not to make themselves responsible for anything by the qualifications which they had made. The shareholders also saw that the auditors were very careful to avoid telling them how the paid-up capital had been spent. In the circular which he (the speaker) had sent out he stated that the paid up capital had been spent, and that in addition the Directors had borrowed a certain sum of money, which they themselves now told the shareholders amounted to £3,500. Therefore the statement which he had made, that the capital had gone, was verified, and beyond that there was a sum borrowed. The whole of the paid up capital was £110,000, of which £40,000 was paid to the vendors, leaving £70,000 to be accounted for. Although in his circular he had purposely directed the attention of the Directors to the point, and challenged them to afford an explanation of the matter, the Directors and the auditors had carefully refrained from saying a word as to how that £70,000 had been spent. In addition to that there was the sum borrowed from the bankers of £3,500 to be accounted for. They had a right to make an investigation into this point. The shareholders would remember that when the Company was brought out great stress was laid on the fact that India offered a very profitable field for telephonic enterprise, and personally he believed that that was so. One would naturally have expected that the Directors would have worked that specially profitable field, but instead of doing so they found that the Board had established two subsidiary companies, one in Bengal and the other in Bombay, and so far as he could trace and so far as the auditors' report went, the Directors had handed over the rights of the Company in Bombay and Bengal without receiving anything for them. He would be pleased if he was wrong, but he confessed he had looked very carefully into the matter. He thought that as to this question they had a right to an investigation by an impartial and independent tribunal. If the Company had got anything for the concession of their rights in Bengal and Bombay it was a further reason to inquire what had become of the proceeds, in addition to the £73,000 already mentioned. Not only had the Directors made over the rights of the Company in Bombay and Bengal, but they had paid the subsidiary companies to take those rights away from them. Estimating the value of the rupee at two shillings, the shareholders would see that the preference shares of the Bombay and Bengal Company amounted to about £98,000, upon which the Directors had given a guarantee for five years of no less than 8 per per cent., involving a charge of over £6,000 a year. He found that the Directors still held about £26,000 of those shares, but that they had parted with £72,000 of shares. What was given for them, how were they induced to guarantee 8 per cent. upon them, and what was the reason for so large an amount being paid? All these he thought were questions that ought to be answered by a committee of impartial shareholders. He had throughout refrained carefully from making imputations against the Directors, but in the circular issued by the Directors they saw that imputations were cast upon this movement of the requisitionists. He admitted that they had thrown an imputation on the Directors if it was to be contended that the proprietors were not justified in inquiring into the affairs of their own property. But he never heard that proprietors had not a right to inquire into their own affairs. He concluded by moving the first resolution.

Mr. ADDISON seconded the motion, and said he wished first of all to call attention to the third paragraph in the Directors' circular, in which they stated "the Board had no hesitation in boldly impeaching the worthiness of the motives of the real instigators of this agitation." Now, he thought that that statement was very unfair. The agitation, if they pleased to call it so, arose in this way. He received a letter from Mr. M'Nab in Scotland, who was the holder of about 1,000 shares, and he wrote to him as a resident in London, asking him to see if he could not find out anything about the Company, with the management of which Mr. M'Nab was dissatisfied. About this time he (the speaker) received the committee's report on the affairs of the Consolidated Company, of which he was a large shareholder. Upon reading that the impression that came to him was the same which occurred to Mr. Lloyd on the receipt of Mr. M'Nab's letter. He remembered that Mr. Akers some time previously had asked him to join a committee with a similar object to what was now proposed. But he found out that it was simply to join Mr. Pender on the committee of consultation which was appointed at the last meeting. Therefore he did not consent to what Mr. Akers proposed, because he (the speaker) knew nothing of what occurred at the last meeting of the Company, although he supposed that something unsatisfactory was said, or no committee at all would have been proposed. The appointment of the consultative committee at the last meeting was, however, a perfect farce, and they therefore proposed now the appointment of an independent one at this meeting Mr. Lloyd had said that they had no charges to make, but they thought that as the Directors were mostly promoters and late Directors of the Consolidated Company that they ought not to remain silent after what was said in the report of the committee which had examined into the affairs of the Consolidated Company. They would see from the list of the Directors of the Oriental Company that Mr. Edison and Mr. Hubbard resided in New York, and Sir William Thomson in Edinburgh. There therefore remained only Colonel Gouraud, Mr. Carnegy, Mr. Bigelow, and Mr. James Pender, and he believed that Mr. Carnegy was away now until next June, so that it practically came to this, that there were two Directors of the Consolidated Company on the Board against one other Director, or, with Mr. Carnegy, there were three Directors of the Consolidated Company against this one other Director. In the report of the committte on the Consolidated Company's affairs they would see that the Oriental Telephone Company was mentioned several times with respect to the different transactions in connection with that Company, and he thought that that rendered it still more necessary to see what those contracts were. He knew from what took place at other meetings a great objection was taken to having committees of investigation. In many cases such appointment might be objected to; but what they had seen attending the inquiries which had been made by the two committees of the Consolidated and the Gülcher Companies proved that such committees were not always to be objected to. Most of the Directors of the Oriental Company to which they were referring had their holdings in the Company in fully paid-up shares, and consequently their interests were antagonistic

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to those of the general body of the shareholders, because it did not matter to those Directors if the rest of the money which had to be called up on the shares was called up. Mr. Lloyd had already referred to the auditor's report, and he (the speaker) did not think that much was to be got out of the report in the way of information by the shareholders, seeing that everything in it was qualified. Mr. Edison, who was the promoter of the Company, had given his proxies to the requisitionists to the extent of about 16,000 shares, a fact which showed that other people besides the requisitionists thought that something ought to be done. The present Directors and promoters had been on the Board and had had the management of the Company since the 14th of February, 1881—nearly four years—and he thought it was time that a change should be made. The Directors had talked of resignation, a proceeding which he regarded as very unfair. For why should they try and intimidate the shareholders by such a threat if the requisitionists carried their point? He concluded by seconding the motion.

The CHAIRMAN, on rising to address the meeting, was asked to put the resolution, to which he replied that the resolution had not been sent up.

Mr. LLOYD requested that the Secretary might read the resolution which had been sent in with the requisition.

The CHAIRMAN said that no resolution had been sent in with the requisition.

The SECRETARY preceeded to read the requisition, stating that the first object was, "To consider the propriety of appointing, and, if thought desirable, to appoint a committee of investigation, to examine into the affairs of the Company, with power to inquire into and report upon all agreements effected with subsidiary and other companies."

Mr. LLOYD said that he would move that a committee be appointed for the purpose stated.

The CHAIRMAN said that he understood that the resolution was as follows (and Mr. Lloyd would correct him if he was wrong, as he wanted the exact language to be given):—"That a committee of investigation, consisting of five shareholders of the Company, be appointed for the purpose of examining into the affairs of the Company, with power to inquire into and report upon all agreements effected with subsidiary and other companies." He asked Mr. Lloyd if that was the resolution?

Mr. LLOYD having answered in the affirmative,

The CHAIRMAN continuing, said that the first thing he wished to refer to was a statement of Mr. Lloyd, which certainly had gone very far beyond anything which that gentleman had stated in his circular. Mr. Lloyd had stated that the members of the Oriental Board who were Directors of the Consolidated Company had retired from the Board of that Company because the report of the committee of investigation of the Consolidated Company had charged them with breach of trust. Mr. Lloyd had said nothing so specific as that in his circular, and he wished to say that Mr. Lloyd's statement here had given him (the Chairman) a very important clue to information which he had desired, because in one of the weekly papers (one of many which had commented somewhat freely in connection with the affairs of the Consolidated Company and of this Company) that precise charge in the exact language of Mr. Lloyd had been made. It was so absolutely untrue that there was any such change in either the first or the second report of that committee that it seemed inconceivable that any one, however careless a reporter or editor of a newspaper might be, could have based such a statement on either of those reports. He had received a legal opinion which he had asked for to the effect that there was not the slightest foundation in either the first or second report of the committee for the statement made in the newspaper referred to, which Mr. Lloyd had now repeated—that was that none of the gentlemen named were charged with breach of trust, and, as the newspaper put it, "other dereliction of duty." He had been informed that it was Mr. Lloyd who wrote the article in question. They were further advised that it was undoubtedly libellous, and that the author and utterer of it ought be well punished, and they proposed to take further action in this matter. He had it on the very best authority that Mr. Lloyd, who had posed so prominently and so feelingly in the matter, had been employed for the purpose of the work he had in hand. He had said that the report of the committee of the Consolidated Company was the first cause (and Mr. Addison had corroborated that statement) of this agitation for a committee of inquiry into the affairs of the Oriental Company. He could not let that statement pass, because it was not true. As a matter of fact it so happened that before the report of the committee was issued, and therefore before any question arose in connection with that report, he received a communication from a gentleman whom he did not know, and did not now know, which was briefly to this effect—that there was going to be a devil of a row in the Consolidated Company, and that a serious attack was going to be made on the Directors of the Oriental Company who were Directors of the Consolidated Company, and the purport of the communication was that the Directors had better get out. That was the plain language of it, but it was to be a little more quarrel at the finish, and words to the effect that if they did not get out they would be kicked out. That they were —— Yankees in control of the Company, and that English people had lost enough of money in American railways, and were not going to have companies managed in London by Yankees. He thought it was a good deal to put on the shoulders of any gentleman the losses which had been made by investing in American railways. This information was repeated to him more than once with a view to their retiring to avoid a row. The matter was considered by them. He wished to say, and it would be in the minds of many of them, that he had been Chairman of this Company something less than nine months, and he was very reluctant to accept the chairmanship, and did so at great inconvenience. Ever since he had been in the chair it had been his desire to be relieved from it; but to be told what he had mentioned to them was the very course of all courses likely to make any man sacrifice his personal convenience, and see the thing out in a manly way. So much had been said about the report of the committee of the Consolidated Company that he particularly wished to say these few words on the subject. Mr. Lloyd had stated in a private letter which he had circulated before his printed statement, that the three Directors of the Consolidated Company who were Directors of this Company were gravely compromised, and that in the second report of the committee they were condemned still more, and Mr. Lloyd also said that he (the speaker) and Mr. Cargill had resigned their position on the Board of the Consolidated Company in consequence of that report. Now those reports—both the first and second—of the committee contained no charge whatever against either of the gentlemen who were Directors of this Company at that time, and he challenged any contradiction of that statement.

Mr. LLOYD, interposing, said he contradicted that statement most emphatically.

The CHAIRMAN observed that probably the meeting would not take any statement on this point in settlement of the question, but he repeated that he challenged the accuracy of the statement which Mr. Lloyd had made. There were, it was true, insinuations without number in the reports of the committee against the Directors of the Company, and more or less against the other ten directors who constituted the Board of the Consolidated Company, numbering fifteen from first to last. There was no denying this, but insinuations could scarcely be answered. His resignation from the Board of the Consolidated Company was not in consequence of the report of the committee. He had before him the proceedings of the ordinary meeting of that Company, at which he gave notice of the circumstances under which he had joined the Company originally (to which he again alluded). He remained in the Consolidated Company until it was out of its difficulties, and the gentlemen who were now Directors of the Consolidated Company were enjoying the fruits of the labour of the former Directors [laughter]. He made that statement deliberately. He (the chairman) seconded the appointment of the committee of the Consolidated Company, and he was glad to have a committee of investigation there. Mr. Cargill did resign in consequence of the report of the committee, to this extent that some one at the meeting said he wished that Mr. Cargill would resign, and some others not wishing to remain did resign, and he resigned immediately, and the resignation both of himself and of some others from the other companies referred to was in consequence of their resignation from the Consolidated Company, as they held their positions in those other companies consequent on the position they held in the Consolidated Company. Mr. Lloyd said he wished to know where the £70,000 had gone, but the various annual reports of the Company had shown where it had gone. He had said that the Company had got nothing from the Bombay and Calcutta companies. He (the speaker) could not conceive a more reckless statement. They got from those companies £34,000, in cash for the £25,000 which they had spent in establishing their businesses up to a certain time, and in addition £19,000 of the guaranteed shares, about which so much had been said. The effect of this transaction was that the Oriental Company got back all they had spent, a large amount in addition, a very large interest in the companies—about two-fifths—and they secured further working capital for the development of the business in those places—working capital subscribed by local people, and to a very large extent by natives. But for this they would, he was informed, have had to leave their money in those businesses, and they would have had to put in the further money which the local people put in, and they would not have had the local support, which was very important in enterprises of this kind. It was very important that such misstatements as those which Mr. Lloyd had made should be corrected He wished also to point out that in the case of Bombay the sale was made by the shareholders. The Board of the Company was then a much larger Board. They called the shareholders together, explained the matter at great length to the shareholders (and Mr. Akers was present, and asked a great many questions), and the matter was unanimously confirmed. In the case of the Calcutta Company the same course was taken, with this difference—that at the confirmation of the sale to the Bombay Company the shareholders gave power to the Directors to do similar business in the future upon their own authority without troubling the shareholders to meet to confirm it. It was almost immediately following the transaction in connection with the Bombay Company that the Calcutta Company was formed, and substantially upon the same lines, with the exception that the public did not come forward so freely as they had done in the case of the Bombay Company, with the result that the Oriental Company had to take a larger interest in the Calcutta Company. Mr. Lloyd had said that the guarantee they had given came to more than £6,000 a year, but the amount of the guarantee was decreased to the extent of the shares held by the Oriental Company. In the case of the Calcutta Company, moreover, there was a provision for a reserve fund of 1¼ per cent., upon which the amount paid to the vendors (that was paid to this Company), had to be invested every year, and which in the course of five years over which the guarantee extended would amount to a very large sum, which the "A and B" shares held by the Oriental Company would participate in. The outside possible losses in fact that could accrue to this Company in the event of the two Indian Companies earning nothing on account of the guarantee until its termination would be about £4,000 a year only.

A SHAREHOLDER asked what the amount of the sinking fund came to.

The CHAIRMAN: £791 a year. This was a reserve fund put aside by the Calcutta Company, and invested in Government paper. Mr. Hall informed him that this charge was part of the working expenses. He contended that the policy which had been pursued in connection with the two Indian companies had been a wise one, and he ventured to say that it was not reasonable to be expected that during the five years over which the Oriental Company's guarantee was to run the Indian Companies would earn nothing, and their receipts were increasing and their expenses diminishing. The shareholders knew that one of the great causes of the slow progress made by the telephone in this country had been the policy of

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the Post Office, and the Directors had it on the best authority that the policy here had been dictated to the authorities in India. Upon the change of policy in England the Directors took the necessary steps to bring about a change in India, and he thought he might say that they had an official assurance that the Indian authorities would be recommended to follow the change which had taken place here. That would have a very important bearing upon the future. As to another of Mr. Lloyd's remarks, none of the Directors of this Company had in any sense been promoters of the Consolidated Company. Allusion had been made to the frequency with which the name of the Oriental Company had been dragged into the report of the committee on the affairs of the Consolidated Company, and that report had referred more particularly to what was known as the 4,000 telephone transaction. He wished to say on that point that the contract for the 4,000 telephone contract in question had absolutely nothing whatever to do with the Oriental Company, and it was impossible to conceive how it ever could have. He would only make one other reference to that contract. The transaction was one that concerned a great many people, nearly all of whom, if not all, were gentlemen above reproach. It was a most complicated transaction, which at its beginning certainly gave no indication of its ending. When he told them that it was a year and a half before that transaction could be settled, notwithstanding that it was in the hands of four of the most eminent firms of solicitors in London, they might form some faint conception of what a difficult transaction it was. As far as he was concerned, he had nothing to regret in his connection with the transaction, and he might add that the three gentlemen whose names had been mentioned in connection with it—Messrs. Bigelow, Cargill, and himself—acted as attorney for some twenty-five different people. That accounted for their names in particular having been associated with it. The gentleman who had seconded the resolution had spoken with very telling effect about the proxies of Mr. Edison having been given to the requisitionists. But the shareholders ought to have begun by saying that after the first circular which the Directors had sent to the shareholders they had determined to call the shareholders together themselves, and they had called a Board meeting for the purpose. But, by a very singular coincidence, that morning, just as they were about proceeding with the business of calling an extraordinary meeting, they received the requisition. But at that time, in anticipation of the meeting which they intended to call, not only the Edison proxies but others which the seconder might have mentioned, which the requisitionists thought they had the support of, were in the hands of the Directors. Reverting to the question of Mr. Edison's proxy, the Chairman said that he had a letter from that gentleman, telling him that Mr. Johnson and Mr. Batchelor, his co-partners in the Edison Company, had sold their shares, and that in doing so they had been obliged to give a power of attorney as to voting on those shares. I——

Mr. OPPENHEIM (interposing) was understood to say, as to the purchase of Mr. Edison's shares, that the remarks of the Chairman were untrue. The speaker afterwards alluded to the part which he had taken in the movement, and to his having backed up Mr. Lloyd, as he had promised, through thick and thin. He had nothing to say against Colonel Gouraud personally, and he was sorry to come into collision with gentlemen who, he was ready to admit, managed the Company according to the best of their lights. That was no reason, however, why the shareholders should not endeavour to get things better managed.

The CHAIRMAN said that the meeting would understand that Mr. Oppenheim had denied having purchased the shares, but he (the Chairman) had not said that Mr. Oppenheim had purchased them. He now wished to give them a few figures as to the progress of the Company. Last year the number of subscribers to the subsidiary companies and to the exchanges worked by this Company was 1,183. Thus, up to the latest dates published, averaging about ten months in the year, the number was 1,532, being an increase of nearly 29 per cent.; and, if the same progress continued for the year, the increase would be 34 per cent. The revenue at the end of the year was £19,800, and for about ten months of this year it had been about £22,600, being an increase of about 14 per cent; and, if this same progress continued for the whole year, the percentage of increase would be nearly 17. The only centre which was really doing very badly was that in Hong Kong, and they had closed that rather than continue to lose money there. Concurrently with the progress he had mentioned, there had been a reduction in the expenses amounting to over £1,000 a year, of which more than £700 was consequent on the Directors taking less fees, and in the ensning year the reduction in the expenses would be still larger. Mr. Lloyd had said that the Company was losing money everywhere in the concern. The subsidiary Companies, however, had worked at a profit, and the Egyptian Company had a larger profit. When the Directors had said that they thought it necessary that there should be such a committee as was now desired, he thought they were justified in saying so in view of the fact of what had been referred to concerning the consultative committee in connection with the powers which the Company had; and though they never came to the place, they could hardly say that they were denied the means of doing so.

Mr. AKERS: I shall deny that most certainly.

The CHAIRMAN said he agreed with the statement made that the consultative committee was a farce, but he thought that that was due to two of the gentlemen who had desired to turn it into something else very different from that of a committee of a consultative character.

Mr. ADDISON said that the Chairman denied the veracity of his account to the meeting of the origin of this movement, and he proceeded to tell what he had previously said on this point.

Mr. ROBINSON KENDALL said he thought it their duty to see whether the seemingly conflicting interests could not be reconciled, and with that view he asked if the Board would accept three gentlemen nominated by the requisitionists for the committee, if the Directors themselves nominated two others [No, no]. He thought that this suggestion might be wisely accepted in the interests of the Company, and that they ought not to have the Company's interests jeopardised by the appointment of a committee with hostile feelings who were determined to go against the Board. He moved an amendment in effect appointing a committee of five shareholders, to be composed of three directly nominated and elected by the meeting, and two nominated by the Board and elected by the meeting.

Mr. VEARES seconded the amendment.

Mr. E. B. Frost remarked that he failed to see anything in what the Chairman had said why the committee should not be appointed, and he thought if there was nothing to conceal that they would court investigation and inquiry. On the other hand, if there was anything to conceal, it was the duty of the shareholders to investigate and find out what was wrong.

Mr. PENDER, M.P., said he believed the whole affair was in a nutshell, and he asked the Chairman to accept what Mr. Lloyd had said he wanted—a fair, impartial, independent committee. He knew that when he left the Company he believed there was no company in a sounder position, and they had heard from the Chairman that its prosperity had materially increased since then. While he maintained that such meetings as this were, as a rule, detrimental to the credit and reputation of a company, he thought that this Company occupied such a position that it might be better to have a fair impartial investigation. The names should be suggested one by one, and then the shareholders should vote separately. He had a large interest in the Oriental Company, and a very large interest in the propress of electricity generally, and great difficulties had to be encountered. This Company only required careful nursing. They had got in India the best possible field for telephonic enterprise, while in Egypt, notwithstanding all the difficulties in that country, they had a most successful company there, and one which was likely to be a great deal more successful with the rebuilding of Alexandria. At Singapore they had a most excellent company, and altogther looking at the position which the Company occupied if they did not quarrel among themselves but would act in union and nurse their affairs, they might depend upon it they that they would come out not only with their money entire but with a very good income for it. He certainly thought the Board required strengthening, for it was weak, although that was from circumstances over which the present Board had no control.

A SHAREHOLDER asked if Mr. Pender would be disposed to act on the committee.

Mr. PENDER said he thought it would be unfair to the shareholders if he did.

Mr. BUCKLEY spoke of the benefits which the Company had derived in connection with the Indian Companies through the influence of Mr. Pender. He suggested, amid expressions of dissent, that two or three gentlemen should be invited by the Board to join them in looking into the affairs of the Company.

Mr. AKERS said it had been his opinion at least twelve months before the appointment of the consultative committee that there should be a committee of investigation, and he trusted that the shareholders would not on the present occasion allow themselves to be led away by any side wind to place any extra power in the hands of the Directors. The consultative committee which had been appointed was a compromise instead of a committee of investigation.

After further discussion on matters of a personal nature,

The CHAIRMAN said that the views of the Board on the subject of the committee were expressed in their circular. They had thought that with the freedom of access which they had offered to all the shareholders no committee was necessary. But he did not think it would be merely on the part of the Board sitting there to say that they would now oppose a committee of investigation. He had had no opportunity of consulting his colleagues on this point, and therefore he must be taken as speaking only for himself. He thought it was desirable that the matter should be settled to-day, and that a committee of investigation should be appointed, but he did think that it should be so constituted as that it would report fairly. He alluded to the large number of proxies which they had received on the faith of the statement made by them in their communication of the 29th November to the effect that if a committee of investigation (meaning always a hostile committee) should be appointed they would oppose it.

After further remarks from Mr. LLOYD, and some further discussion as to the manner in which the names of the committee should be submitted,

The CHAIRMAN put the amendment, which was lost on a show of hands. He next put the original motion, which was carried.

The following gentlemen were afterwards appointed the committee of investigation:—Messrs. William Edison, G. B. Frost, Martin Jaffé, T. Lloyd, and St. John Akers.

Mr. LLOYD said it was the general opinion that the Board was too weak, and they desired to strengthen it. He therefore proposed the election to the Board of the Right Hon. G. F. Cavendish Bentinck, M.P., Mr. St. John Akers, Mr. William Edison, Mr. John Battams, and Sir Alexander Armstrong.

The motion having been seconded,

An amendment was moved to the effect that the question of appointing Directors should be deferred until the committee presented their report. After some discussion,

The CHAIRMAN said that it was not the intention of the existing Board to remain responsible for the position of the Company with the committee going on, and therefore unless the meeting elected Directors they would be a company without a Board.

The amendment was then withdrawn.

The resolution as proposed was carried.

The CHAIRMAN said that notice had been given of a further resolution (relating to the remuneration of the Directors), but he would take the responsibility on behalf of the Board of withdrawing in.

The proceedings then terminated.

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NOTES.

PATENTS.—The number of applicants for Letters Patent during the year just ended amounted to 17,110.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 26th Dec. amounted to £3,217.

APPOINTMENT.—Captain Beresford, R.E., succeeded Major Turner as Superintending Engineer of the Southern District of England on 1st January.

ELECTRIC LIGHT IN BERLIN.—The contract between the Berlin Municipal Authorities and Siemens u. Halske for the electric lighting of the Potsdamer Platz expires on 1st March, but is to be renewed.

THE MICROPHONE IN COLLIERIES.—The new microphone invented by M. Hipp, of Neuchâtel, is being tried at the Mariemont Colliery, Belgium, for signalling between the surface and the underground workings.

TRAIN LIGHTING.—On Tuesday last a successful experiment in train lighting was made on the South-Eastern Railway, two trains between London and Maidstone being provided with incandescent lamps, which gave a brilliant and steady light.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ended 26th December were £2,557, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

COMPAGNIE INTERNATIONALE DES TELEPHONES.—At the special general meeting on 18th Dec., it was decided to wind up this company, as reported in another column. The *bulletin* will therefore cease to appear, but will be continued in another form.

ELECTRIC ILLUMINATION OF THE ADELSBERG GROTTO.—This stalactite cavern is now illuminated by twelve 1,500-candle arc lamps, the light for which is reflected by the crystalline surfaces, revealing beauties hitherto unknown even to the guides.

POSTAL TELEGRAPH REVENUE.—The revenue of the Post Office telegraphs for the nine months just ended shows a decrease of £5,000, compared with a corresponding period in 1883. Mr. Childers estimated that there would be an increase of £55,000 for the whole year.

ATLANTIC CABLES.—The two Bennett-Mackay cables have been repaired, and the lines opened for traffic. The rate charged for messages was two dollars per word. In face of this competition the existing companies have also reduced their tariff from 2s. to 1s. 8d. per word.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th Dec. are £2,190, as compared with £2,251 in the corresponding period of 1883. The September receipts, estimated at £4,083, realised £4,143.

KABATH ACCUMULATORS.—We learn from the *Rivista dell' Electricità*, that these accumulators have been used in connection with Gaulard and Gibbs' secondary generators, by which the transformation may be effected, not only from series to quantity, but also from quantity to series.

THE TELEPHONE IN ITALY.—The Società Generale Italiana dei Telefoni has, with the co-operation of Commendatore Florio, of the Rubattino Florio Company, constituted a local telephone company, the Società Meridionale dei Telefoni, the chairmanship of which has been offered to Sig. Florio.

TEMPORARY LIGHTING.—The Società Industriale Franco-Italiana has provided a portable plant, consisting of dynamos, accumulators, incandescent lamps and conductors, for undertaking by contract, on the occasion of *fêtes*, &c., temporary lighting, as well as telegraphic and telephonic communication and protection from lightning.

ELECTRIC LIGHT AT THE PARIS EXHIBITION, 1889.—M. Eiffel has designed a wrought-iron tower, 300 metres = 984ft. high, for carrying powerful arc lights, capable of illuminating the whole Exhibition and its approaches, while, in case of war, a search light on the top would shed its rays over the country round for 60 kilometres or 40 miles.

PROPOSED EXHIBITION AT TRAUTENAU.—According to the German press, an exhibition of commerce, industry, electricity, agriculture and forestry, will be held in 1886 at Trautenau, the political centre of the Riesengebirge district. It is expected that the support of the various branches included in the scheme will make the enterprise a success.

INTERNATIONAL SOCIETY OF ELECTRICIANS.—The Société Internationale des Electriciens will hold its ninth ordinary monthly meeting on Wednesday next, 7th inst., in the hall of the Société de Géographie, Paris, when papers will be read on the Principal Applications of Electricity to Railways, by M. F. Rodary, and on an Electrical Meter, by M. G. Lippmann.

THE CREIL EXPERIMENTS.—It is hoped that the plant at Creil will be ready for working during the present month; and that the intended current of 20 amperes at 7,500 volts will then be generated for transmission to Paris. The French Government is imposing stringent regulations as to the protection of the conductors, so as to guard against accident.

BOILER SCALE AND ELECTRICITY.—A correspondent to the *bulletin* of the Compagnie Internationale des Téléphones states that existing boiler scale may be detached by keeping the poles of a 10 or 12-cell Bunsen battery connected with the ends of the boiler for 30 or 40 hours, and that afterwards the plates may be kept clean by a weaker current similarly applied.

THE LATE M. LATIGUE.—At the last meeting of the Société Internationale des Electriciens, the president, M. G. Berger, in speaking of the late director of the Société Générale des Téléphones, who was also one of the founders of the first-named society, said that without Latigue the Paris Electrical Exhibition of 1881 would certainly not have been so successful as it was.

GENERAL TELEPHONE COMPANY.—M. A. Berthon, chief engineer of the technical service to the Société Générale des Téléphones, has been appointed engineer-director of the construction and working department. The *Bulletin* says that M. Berthon, past president of the Société Amicale des Elèves de l'Ecole Centrale, is the first engineer to make a practical application in France of the Edison telephones.

INSTITUTION OF CIVIL ENGINEERS.—Yesterday was the anniversary of the foundation of the Institution of Civil Engineers, which was established on January 2, 1818. From a new list of members just printed it appears that there are now on the books twenty honorary members, 1,447 members, 1,889

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associate members, 508 associates, 804 students, together 4,686, against the total at the same date last year of 4,443.

THE INTERCOLONIAL TELEGRAPHS, VICTORIA.—The last consignment of telegraph wires for the extra intercolonial lines between Melbourne and Albury had come to hand in excellent condition; and every effort was being made to push forward the construction of the new wires. It was expected that the work would be finished by November 20. The extra line from Sydney to Albury has been available for some time. —*The Colonies and India.*

LONG-DISTANCE TELEPHONY.—At the request of the Portuguese Minister of Public Works, M. Van Rysselberghe gave a lecture on his system, at Lisbon, before the King and Queen of Portugal, the Ministers, the high functionaries of State, and the leading scientific men. At its conclusion, oral messages were exchanged between the capital and Cintra; and the Belgian *savan* was warmly congratulated by the king on his important discovery.

UNION ELECTRIC LIGHT AND POWER CO.—By an order made on 6th of December, 1884, on the petition of Dillwyn Parrish, and Alfred Parrish, of 2, Copthall-buildings, E.C.; John Goddard, jun., of Elmer Lodge, Elmers End, Beckenham; and Jas. Fyfe, of St. Stephen's-chambers, Telegraph-street, E.C., electrician, it was ordered that the voluntary winding up of the Union Electric Light and Power Company be continued, but subject to the supervision of the Court.

ELECTRIC LIGHT AT THE ANTWERP EXHIBITION.—The Managing Committee intend to divide the lighting of the Exhibition into three portions, in one of which a single system will be chosen, in another all kinds of appliances for gas lighting will be admitted in competition, and for the third electric engineers and electric lighting companies, English included, are invited to go in for certain areas, as at the late Health Exhibition, in order to demonstrate the value and adaptability of their systems.

ELECTRIC POWER FOR THE ORLEANS RAILWAY COMPANY.—The Compagnie Electrique has put down electric plant at Vitry, for the Compagnie de Chemin de fer d'Orleans. A No. 5 electric generator, driven by a steam engine distant about 180 metres (590 feet), yields, at 1,100 revolutions a minute, a current the tension of which does not exceed 140 volts. The No. 3 electric motor, placed in a cellar, gives out 50 kilogrammetres (361 foot-pounds), working a rotary pump and other machinery.

ELECTRIC LIGHTING AT ANTWERP.—The Compagnie Générale d'Electricité is laying cables on the Callender system, for lighting the eastern district of the city by 6,000 Gülcher incandescent lamps, maintained by Gülcher dynamos. The cables are laid underground in cast-iron troughs of rectangular section, fitting one into another, and closed by wrought-iron cover plates, the interstices being filled up with pitch. This lighting plant, the most important yet undertaken by the company, is to be ready by February.

GADOT'S ACCUMULATORS.—Signor Paolo Gadot is stated by *Il Giorno* to have invented some new secondary batteries which have an electrical capacity almost double that of the Faure-Sellon accumulators. He makes four types, suitable to domestic applications, such as lighting, electro-deposit, and the working of small motors. The lead electrodes are, as usual, coated with oxide, but are immersed in a liquid, the composition of which is at present kept secret, and which, while effecting depolarisation, facilitates the attack of the metal plates.

THEATRE LIGHTING.—The contract for providing the two Court theatres of Berlin with 4,500 incandescent lamps has been entrusted to the Städtische Electricitätsgewerbe, who will lay the conductors during the winter, and install the lamps and internal fittings during the summer, when the theatres will be closed. At the new concert hall, Leipsig, 500 incandescent lamps are fitted to the gas brackets, and maintained by 120 Epstein accumulators, charged by a dynamo, driven by an 8-horse gas engine that is started about twenty-five hours before the light is wanted.

TRAVELLER WORKED BY ELECTRICITY.—For some years past a travelling crane has been worked by current at the Bourges Cannon Foundry in France; and M. Marinoni is now turning his attention towards applying the same system to a traveller 20 metres long and 7 metres high (65 by 23ft.), with a travel of 90 metres, or 295ft., at his Parls works. A No. 5 motor of the Compagnie Electrique makes the lift (up to six tons), while a No. 4 serves to effect the travelling motion. At 1,100 revolutions the generator gives out a current the E.M.F. of which does not exceed 250 volts.

TRANSIT TABLES FOR 1885.—We have received from Messrs. E. and F. N. Spon a series of tables computed from the "Nautical Almanac," for popular use, by Latimer Clark, M.I.C.E., M.S.T.E., &c., by means of which any one may obtain accurate time in any part of the world by a simple observation of the stars without any calculation. There are full directions for obtaining Greenwich time, local time in England and other parts of the world, and Greenwich time, as well as district time at foreign stations. But why in this high-pressure age are not the leaves machine-cut?

A POINT IN THERMO-DYNAMICS.—At the meeting, on 15th December, of the Paris Academy of Science, M. H. Lechatelier proposed to verify an important point in thermodynamics, if, in consequence of a progressive elevation of temperature, the heat of transformation changes rapidly (as is the case on the fusing of one of the bodies under consideration), the angular coefficient of the tangent to the curve of the pressures will also change rapidly. For this purpose he investigated the dissociation of hydrate of chlorine, and found an agreement between theory and practice greater than he hoped for.

WESTBOURNE-GROVE.—We understand that Mr. William Whiteley, of Westbourne-grove, has purchased the 1,000-light Ferranti machine which was recently exhibited at the Health Exhibition, and which obtained the gold medal. It is interesting to know that the machine of the same type, exhibited last year at the Fisheries Exhibition, was also purchased in that case for South Kensington. Mr. Whiteley, we understand, is not trying the Ferranti machine for the first time, but has had a small 200-lighter actually running 350 incandescent lamps; and, notwithstanding the severe strain, the machine is still in good order.

OURSELVES.—"*The Electrician*, Vols. XII. and XIII., shows the progress made from week to week in the development of electricity as the servant of man during the past year. This period has not been marked by any special activity on the part of the inventor. It will be remarkable rather for the survival of the fittest, for reductions of capital, liquidations, and amalgamations. And those who desire to trace the history of the critical struggles of the various companies and inventions to survive these days of public suspicion and neglect will find all they require in these volumes of *The Electrician*, besides much of interest concerning the telegraph and the telephone."—*Pall Mall Gazette.*

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ABUSE OF THE TELEGRAPH.—We recently had occasion ot denounce gambling by telegraph; and we would now call attention to another species of the vice, as real if not so ostensible. Since the hourly variation of prices at the Stock Exchange has been telegraphed to a dozen different offices in the City, outsiders have been enabled to deal almost as closely as members; and their number has increased while their status has decreased in inverse ratio. The Committee of the Stock Exchange have this matter under consideration; and it seems not unlikely that the "tape system," as it is called, will be excluded from the hallowed precincts of the Exchange—that is, supposing the Committee are in earnest about the matter, and the outside gambling fraternity does not prove too powerful.

GAS OR ELECTRIC LIGHT.—The question as to the relative economy of gas and the electric light was lately discussed by the Société Industrielle du Nord de la France, when a large number of manufacturers who had adopted one form or other of the electric light expressed themselves highly satisfied. After a report presented by M. Gaillet on various electric lighting installations, M. Melon, a gas engineer, spoke in favour of gas, especially on the score of economy. He attacked the installation of the Magazins du Printemps, Paris, and stated that such an establishment at Lille, with gas at 12 centimes per cubic metre, would effect a saving of 21 per cent. by using gas instead of electric light. This is probably the case, though far from being so at Paris with gas at 30 centimes per cubic metre.

THE TELEPHONE IN FRANCE.—By an arrangement made between the French Minister of Posts and Telegraphs and the Société Générale des Téléphones, subscribers to the Paris Telephone Exchange will, in a short time, be able to despatch and receive their telegraphic messages by telephone, a telephone service, to be available day and night, being now in course of organisation at the Central Telegraph Office. Such telegrams will not be charged extra; but the telephone subscribers must pay an additional 50f. or £2 per annum. M. Van Ryssel-berghe, of long-distance telephony fame, has had an interview with M. Cochery, the French Postmaster-General, with reference to telephonic communication between Rouen and Havre, in the telegraph offices of which towns the necessary arrangements are already in progress.

THE SENEGAL CABLE.—A Reuter's telegram to the *Standard*, dated Lisbon, 29th December, says that on that day the Spanish Colonial Minister went on board the steamer "Silvertown," which is about to sail for Africa to lay the Senegal cable, and to make soundings preparatory to the laying of the Portuguese cable. After inspecting the ship, the Minister, who was accompanied by Mgr. Vanutelli, the Papal Nuncio, M. de Laboulaye, the French Minister, and Baron Greindl, the Belgian Representative, delivered a speech, in which he expressed the hope that the civilising work about to be begun—the initiative of which emanated from Portugal—would be successfully accomplished. Portugal had already rendered services to humanity on the African Continent; and it was to be hoped that this new line of electrical communication would serve as a bond of union between Portugal and the Powers interested in the development of their West African Colonies.

SERMONS BY TELEPHONE.—In this connection, Mr. J. D. Miller, one of the district managers of the National Telephone Company, writes to the *Aberdeen Herald* as follows:—"Sir: With reference to the leader in your paper on the American article of 'Talmage on Tap,' it ought to be made known to your readers that all that is hoped for in the connection of the Brooklyn Tabernacle with the telephone exchange there has already taken place, with brilliant success, in this country. On this company's system, churches in Birmingham and Bradford have been in connection with the exchanges in these towns for two years now. The first connection of a church with a telephone exchange in this country was that of the George-square Congregational Church in Greenock, which I connected up so far back as June, 1882, ever since when sermons and the entire services have continued to be 'served hot' each Sunday to a number of private residences in Greenock, and at the same time several in Glasgow—a distance of over 22 miles."

ROYAL REWARD FOR TELEPHONING AN OPERA.—The King of Portugal has just conferred the honour of Cavalliero do Christo on Mr. Alan Danvers, engineer and manager to the Edison Gower-Bell Telephone Company at Lisbon. Mr. Danvers has received this distinction in consequence of the following interesting circumstances:—Some little time ago the King of Portugal was prevented from attending the first performance of the opera "Lauriana" through the death of the Princess of Saxony; and neither the King nor the other members of the Royal Family would have heard anything of the opera, had not Mr. Danvers come to the rescue and suggested that he should telephone the opera from the house to the Ajuda Palace. The King, delighted at the proposal, immediately acquiesced. The result proved most satisfactory, as both the music and the words are stated to have been perfectly distinguishable; and the King shows his appreciation of the fact by conferring this honour of knighthood on Mr. Danvers.

EASTERN COMPANY'S CABLE IN DANGER.—The indecision of the Government in enforcing the provisions of the Foreign Enlistment Act, which has already been proclaimed in the former place, is attributed in well-informed quarters to the weakness of our squadron in the China Seas. An incident which strongly reveals our weakness there has hitherto been kept secret, and has only become known in London quite recently. After the bombardment of Foochow, the pirates in the Min River, taking advantage of the disorder, attacked the hulk which forms the terminus of the Eastern Telegraph Company's cable at Sharp's Peak, near the mouth of the river. The *employés* were compelled to fly for their lives, leaving the hulk and instruments in the hands of the pirates. An application to Admiral Dowell for a gunboat to protect the station of this important English company was met by the reply that there was not one to spare; but the English Admiral applied to Admiral Courbet to give the protection which he could not afford himself. A French gunboat was accordingly told off for the duty.—*Pall Mall Gazette.*

ELECTRIC LIGHTING IN GLASGOW.—The Town Council of Glasgow appear quite resolved not to permit any general scheme of electric lighting to be carried out by companies or private individuals within the municipality. When the subject was before the Council some time ago, a main objection urged was that the overhead wires were becoming far too numerous in the city for the public safety. This was one of the reasons brought against the application of Messrs. Woodhouse and Rawson, electricians, of London. Bearing this in mind, doubtless, a local firm, Messrs. Muir and Mavor, recently asked permission to open up Miller-street, Ingram-street, and Hanover-street, for laying underground wires, for the purpose of supplying electricity, which is generated in their premises in Miller-street, to the General Post Office. The Council have declined to sanction the work. As owners of the gasworks, the Corporation is deeply interested in the question of public lighting. They make no objection to firms supplying their

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own wants by electricity—probably they lack the power to interfere in such cases. But now it is proposed to sell or trade in the light, the Council, drawing the line at that point, step in with their prohibition. They believe that if electric lighting is to become general at any future time they ought to have the exclusive right to supply it as the representatives of the community.—*Gas and Water Review.*

FIRE AND THE TELEPHONE.—Mr. C. G. Wright, the Edinburgh district manager of the National Telephone Company, writes as follows to a northern contemporary:—"In your issue of December 17th there appeared an account of a fire which occurred at the Tyrie Bleachworks, near Kirkcaldy, early on the morning of the previous day. It is stated that 'on the burgh fire brigade arriving on the scene, the roof was found to have fallen in.' Another account states that on the discovery of the fire 'a man was despatched on horseback for the Kirkcaldy fire brigade.' The owners of the Tyrie Bleachworks were lucky in having a horse and rider so handy, but had they possessed communication with the Kirkcaldy Telephone Exchange (which is open day and night), the fire brigade would have arrived at the scene about the time that the man on horseback was galloping up to the fire station with the alarm, and the roof would probably have been standing now. A marked contrast to this occurrence was the fire at the Kirkcaldy Linoleum Company's works on June 30th last. In that case communication with the Telephone Exchange existed, and by its aid the burgh fire brigade and the private engines of several firms were called with such promptitude that, although the building and contents were valued at £40,000, and the fire, when discovered, had obtained considerable hold, the total damage done was under £500."

INTERRUPTION OF THE ST. VINCENT CABLE.—At about 11 a.m. on the morning of the 28th November, the new cable to St. Vincent was suddenly interrupted. At first it was considered that a land-line had "gone wrong;" but a visit to the cable-house settled the matter, the tests pointing to the break being a very short distance from shore, though in comparatively deep water. Our superintendent at first thought of attempting the repair himself; but Mr. Blandy was unwilling to risk one of his lighters, as the weather had been and still was threatening. Accordingly the "Kangaroo" arrived at Madeira, December 15th, and found the break to be a little over half a knot from the cable-house. We are now "through," and working well. A curious feature in connection with this rupture, evidently the work of a ship's anchor, was that although our end of the break made "earth" after a fashion, the broken extremity of the St. Vincent end was completely sealed by the gutta percha which had been pulled and pressed over it. A better or more effective seal, they say, could not have been made by a jointer, and on its being tested after being brought aboard it showed no loss whatever. As might be expected, from the time the interruption took place, St. Vincent's tests gave as results the D. R. of all but the entire cable. On the Madeira end being brought aboard, it was found to be almost sealed—in fact, none of the conductor could be seen, but only felt. The electrical resistance of this break was about ten or twelve units.—*Monthly Correspondent, Madeira.*

PHOSPHOR BRONZE CONDUCTORS.—*A quelque chose malheur est bon*, or "'Tis an ill wind blows nobody good," was exemplified in Brussels on the 9th December last, when a gale broke 130 telephone wires, all of iron or galvanised steel except two, which were of phosphor bronze and cut at the fastening. *Apropos* of this *contretemps* M. Emile Bède points out in *L'Ingenieur-Conseil* that 2-mm. iron or steel wires are not to be depended upon, on account of their being subject to the action of oxidation and also disintegration from smoke. He has accordingly employed phosphor bronze for the additional lines which he has put up in Brussels and also for the whole of the Ghent system. Though their diameter is only 0·8 mm. they stand, while iron and steel wires of 2 mm. diameter give way after four years. The Bell Company now uses phosphor bronze wires of 1·25 mm. diameter, which, besides being easier to put up, offer a greater security against accidents. M. Bède states that all the 0·8 mm. phosphor bronze wires which he has tested, after being up a year, have preserved both the diameter and the tenacity that they had originally. He looks forward to the time when not only telephone but also telegraph lines will be laid with phosphor bronze wires of high conductivity. Although telegraph wires of 4 mm. diameter are capable of standing longer than telephone wires of 2 mm., on account of the greater reduction in sectional area of the latter by an equal amount of oxidation, while their tension is less on account of the supports being nearer together, they soon become bad conductors, because a half-millimetre of oxidation, reducing the diameter of the wire from 4 to 3 millimetres, increases the resistance in the ratio of 9 to 6.

SHIP LIGHTING.—The Swan lamps on the Great Eastern Company's ss. "Norwich" have now been in use a year and seven months. Though only guaranteed for 1,000 hours' service, they have, with the exception of those accidentally broken, held out for more than four times that period. The carbon filaments of a few are now showing signs of dwindling away; and the chief steward has put one up in his cabin, so as to watch and see how long it really will last. We recorded, a month or two ago, the only hitch that had occurred in this remarkably successful lighting; and that was due to the belt slipping off. This belt, of cotton, which has been on since the commencement, gave way suddenly the other night; but a new one was fitted on directly, with a cessation of less than an hour in the electric lighting. It is hoped that the difficulty of yielding suddenly without warning is now got over by the use of a silky cotton belt, or rather rope, with a very long splice. The 1st and 2nd engineers of the vessel have fitted 14 extra lamps in the engine room and in their own cabins, without any assistance from electricians, the light from the 60 lamps in the saloon being rather improved than otherwise. The dynamo may be run at a still higher speed if necessary, so the engineers propose to put up lamps in the second-class cabin, the smoking saloon, and the captain's cabin, all to be maintained by the same dynamo. As the navigation of the Scheldt is so difficult that it has to be accomplished by daylight, thus involving an early start in the winter months, and as the Dutch Government does not seem inclined to improve the channel, we would recommend the company to be independent of daylight by fitting up a couple of projectors, with powerful arc lights, so as to illuminate the way ahead, and therefore give more time before starting from Antwerp.

THE E.M.F. OF BATTERIES.—When a battery is formed by a single liquid (says D. Thommasi in *Kosmos*) its electromotive force is equal to the difference of the thermic constants of the metal attacked, and of the disengaged hydrogen, divided by the volt expressed in *calories* (463). If it be desired to determine the electromotive force of the copper-zinc couple immersed in diluted sulphuric acid, according to the general formula $E = \frac{\theta H^2 - \theta Zn}{V}$ or $E = \frac{2 \times 61{\cdot}5 - 88{\cdot}8}{46{\cdot}3} = 0{\cdot}7386$ volt, the thermic constant of hydrogen being 61·5, and that of zinc 88·8. The E.M.F. of the same couple is found by direct experiment to be 0·81 volt. If this value is greater than that shown

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by theory, the circumstance is due to secondary actions independent of the chemical reaction of the battery. In fact, the E.M.F. of a couple with single liquid varies with the nature of the inactive metal, and may attain, with carbon for instance, as much as 1·4 volt (at the instant the circuit is closed), although the heat disengaged by the chemical reaction is always the same. The E.M.F. of a single-liquid battery is the same, whatever be the nature of the acid employed, and does not depend on the metal attacked. An exception must, however, be made in the case of acids capable of being reduced by hydrogen, or more exactly by H + calories, as in the case of chromic, nitric, and other acids. These reductions were formerly explained by admitting a special condition of hydrogen, the *nascent state*; but, since 1877, the author pointed out that, at the moment hydrogen is set free, it owes its reducing properties, not to its nascent state, but to the quantity of heat disengaged. The law above enunciated will not hold good if the metal, which should be inactive, is partially attacked by the liquid, as in copper-zinc, zinc-aluminium, and other couples, immersed in hydro-chloric, hydro-bromic, and other acids.

Electric Light at Temesvar.—With respect to the lighting of this, the third town in importance of Hungary, Mr. Frank Schlösser, secretary to the International Electric Company, writes to the *Daily News* as follows:—Referring to Reuter's telegram of 25th ult., to the effect that the town of Temesvar, in Hungary, was left in darkness in consequence of the breakdown of the electric light system which has been established there by this company, I am instructed by my Board to ask you to be so kind as to give publicity to the fact that the interruption referred to, which occurred on one night only, was not caused by a breakdown of the electric light system, but by a sudden failure of the water supply for boilers and condensers consequent upon the blocking up of the Bega Canal by an exceptionally heavy fall of snow followed by hard frost. With the exception of the above single interruption, against the repetition of which the necessary precautions have been taken, the lighting by electricity of the whole of the public thoroughfares of Temesvar (over 40 miles in length) has been in continuous and perfectly satisfactory operation since the first of November last. The experts called in by the Town Council to examine and report on the works were on the spot at the time of the accident, and were able to verify its cause. The result of the report they have since sent in has been a unanimous vote of the general assembly of the Town Council to accept for a permanency the electric lighting of the streets, as complying with the terms of the contract made by the town with the International Electric Company. The first permanent establishment of a system of electric lighting for a whole town is a matter of considerable public as well as historical importance, because most Continental concessions for the lighting of towns by gas contain a clause rendering it obligatory upon the concessionaries to supersede gas by any other system of illumination which may have proved itself superior by practical experience.

Compounds obtained by Means of Gas Batteries and the Silent Discharge.—The apparatus employed by A. Figuier (*Compt. Rend.*) consisted of two hollow graphite cylinders closed at one end, and coated internally with spongy metal or spongy carbon so as to prevent polarisation. These cylinders were supported by a lid which closed hermetically the vessel containing the liquid conductor, the latter being alkaline when the product of the reaction was acid, and *vice versâ*. In some cases the gases were subjected to the silent discharge before being placed in the battery. The compounds produced are formed in contact with the poles, and in greater abundance at the positive pole. Although the current produced may be very feeble, the energy of the reaction may be relatively large. In the following table the substance placed second constituted the positive pole:—

Air and sulphurous anhydride	produce	sulphuric anhydride.
Hydrogen and chlorine	,,	hydrochloric acid.
Oxygen and chlorine	,,	chloric acid.
Nitrogen and oxygen	,,	nitric anhydride.
Hydrogen and nitrogen	,,	ammonia.
Carbonic oxide and sodium carbonate	,,	sodium oxalate and formate.
Ethylene and oxygen	,,	formic & acetic acids.
Hydrogen & carbonic anhydride	,,	formic & acetic acids.
Methane and carbonic anhydride	,,	acetic acid.

The ozonisers employed were provided with armatures coated with platinum black, and were so arranged that their temperature could be raised. Under the influence of the discharge oxygen combines directly with sulphur, selenium, chlorine, iodine, and bromine, but has no action on tellurium. Hydrogen combines with sulphur, selenium ordinary phosphorus and nitrogen, but has no action on tellurium, arsenic, antimony, and red phosphorus. Oxygen oxidises formic acid and formates, carbonic oxide combines with hydroxides, &c.—*Jour. Chem. Soc.*

Treating Sugar by Electrolysis.—The complete extraction of juice from what is generally but erroneously called beetroot—*betterave* is really mangold wurtzel—is rendered very difficult on account of the presence of alcalis in the juice, which prevent the crystallisation of the sugar. A process for neutralising these alcalis has been patented by M. Despeissis, whose invention has this further advantage, that the salts contained in the saccharine solution are obtained in such a manner that they can be turned to profitable account. The process is founded on the fact that, if an electric current be made to traverse a liquid containing a salt in solution, the base of this salt, which is decomposed, is transferred to the negative, and the acid to the positive pole. If there be a porous diaphragm between the two poles, so that the current may pass, but the two liquids can only mingle slowly, the acid and the base of the salt, set free, cannot immediately recombine. The current is to be produced by dynamos or batteries; and the electrodes that M. Despeissis prefers to use are those of carbon or platinum, while the porous jar may be of unglazed clay, carbon, or parchment. During the electrolysis, it is especially the carbonic acid which is disengaged; and this acid, which partially remains in solution, is not injurious to the sugar, while it may also be neutralised by lime. When the liquid is raised to a suitable degree of heat, this carbonic acid is neutralised by the formation of insoluble carbonates, which, on being deposited, also take with them the colouring matters. The syrups and molasses may be treated by the action of heat; and this method has the advantages, that the hot liquid offers less resistance to the electric current, and is sufficiently fluid to render the addition of water unnecessary. Moreover, the high temperature facilitates the escape of the gases which are not deposited on the electrodes. The elimination of the alcalis is effected by means of a filled vessel placed in the juice, and in which the negative electrode is immersed; it is also advantageous to immerse the positive electrode in a porous jar filled with water, and placed in the body of the juice. In this manner the acids and the iron contained in the saccharine matter go to the positive electrode, and the alkaline bases to the negative electrode. The porous jars facilitate the separation of these substances, which are injurious to the saccharine juices, thus permitting a higher proportion of crystallisable sugar to be obtained.

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THE STEAM ENGINE INDICATOR.—V.

BY AMICE.

There is yet another indicator which, by reason of its good qualities, and especially of its steadiness in working at high speeds, has claimed a good deal of attention amongst English mechanicians during the past year or so, namely, the indicator made by the Crosby Steam Gauge and Valve Company, of Boston, U.S., a company whose London office is in Cross-

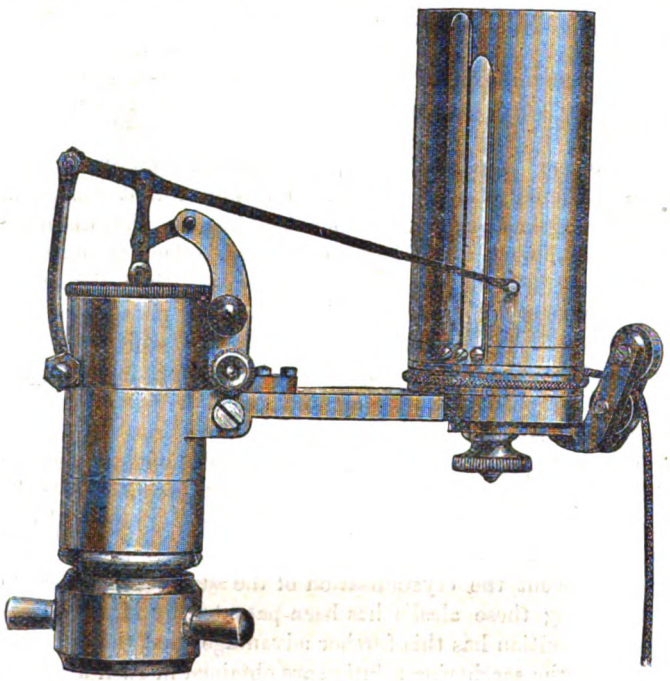

FIG. 20.

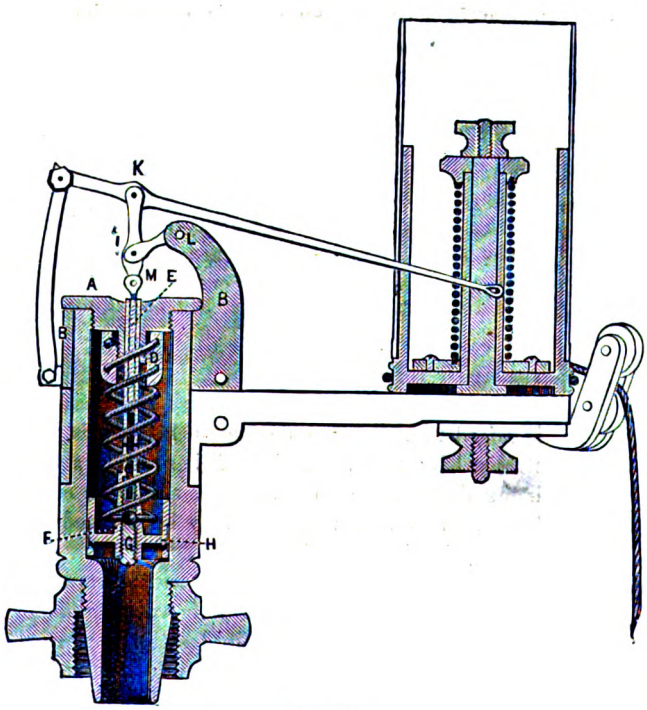

FIG. 21.

street, Finsbury. This indicator we must illustrate and describe, as it affords a good example of that capacity for the development of an invention which seems to characterise American inventors of a large class, and it is noteworthy that the indicator which has held its own for so many years, viz., the Richards, was also an American development of the English invention.

The Crosby indicator is illustrated in perspective and in section by Figs. 20 and 21. Both these views show the lightness of the pencil motion, the general simplicity of the whole indicator, the simple arrangement of piston, piston-rod, and spring. The spring differs in one feature from those used in any previous indicator, namely, that its lower end is not rigidly fixed by a screwed collar on the piston-rod, but the spring itself is a double twist of one piece of steel wire, to the middle of which is attached a small steel sphere, which sits in the hollow piston rod, as shown in Fig. 21, so that the spring is free to adjust itself and to allow the piston and rod to move freely and without the slight friction which want of absolute centralism of the internal and external screws of the usual arrangement sometimes cause. The Crosby spring, seen at full size in Fig. 22, is screwed rigidly to the top cover, as in other indicators, so it needs to be as accurately made in this respect; but the freedom given at the piston end is undoubtedly of advantage, while the lightness of that end is of much greater importance, as this part receives the same motion as the piston.

Turning to Fig. 22, it will be observed that the head by which the spring is held to the cover A (Fig. 21) is large and heavy. Here, however, size is of great advantage, for it secures the advantages of a method of holding that end of the spring which enables the manufacturers to adjust the scale of the spring with great facility. In the ordinary way it is customary to effect the final adjustment of the scale of springs, or, rather, to give them the necessary range with a given amount of pressure by grinding the wire of the spring after it has been tempered. This, it need hardly be said, is not a simple operation, and to some extent affects the uniformity of the sectional area of the spring wire, and therefore detracts from

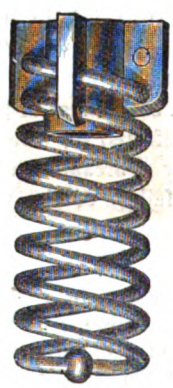

FIG. 22.

the desired uniformity of flexure throughout the length of the spring. In the Crosby spring, however, the two ends of the wire are (the spring being like a double spring) screwed or threaded into the holes, drilled on the wings of the head, and all that need be done to adjust their scale is to screw them in or out of this head. During compression, spiral springs often compress round an axis which is not either a perfectly right line or a fixed one. The advantage of the freedom given by the ball joint connection of the piston and spring is therefore of much importance, considering that it is the attention to these many small things which makes up the superiority of the modern indicators. It will be seen from Fig. 21 that the joint part E of the piston rod screws into the upper part of the tube C, which, at its lower end, screws into the upper part of the boss of the piston H. The screw G in the piston is to adjust the grip on the ball joint of the spring. At F round the piston are small chambers into which steam finds its way to cause the piston to maintain a central position in the cylinder.

Turning to the paper drum, seen in section in Fig. 21, it will be observed that round the central spindle is a spiral spring. The upper end of this spring is fixed by the nut and collar at the top of the spindle, the lower end being attached to the bottom part of the drum. By loosening the upper nut and turning the collar either the one or the other way, and then setting it fast by the nut, greater or less tension may with facility be put upon the spring to suit the speed at which the engine to be indicated is running. This spiral spring does not give a uniform tension throughout the rotation of the

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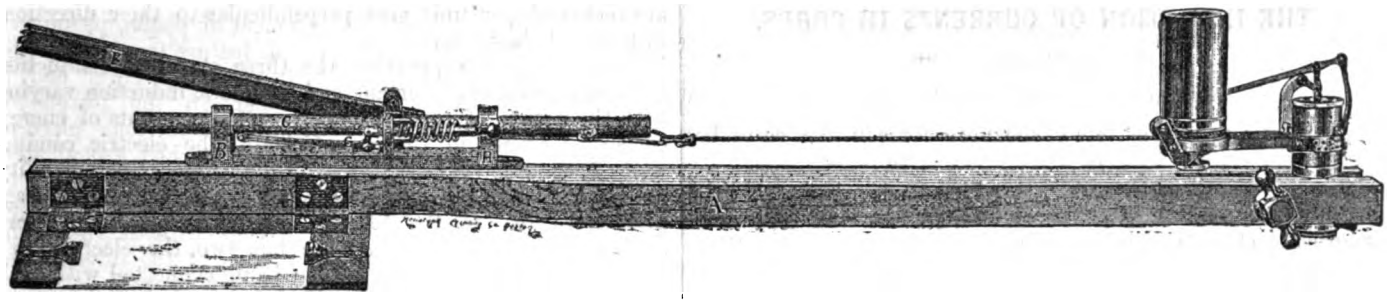

Fig. 23.

drum. It happens, however, that the increasing resistance of the spring as the cord pulls it to the end of the stroke, is exactly what is required for high speed indicating. For instance, at the end of one and the commencement of another stroke the indicator drum is at rest for an assignable length of time whatever the speed of the engine. From rest it is jerked into motion, in some cases of very high velocity. When this is the case the string has considerable work to do in overcoming the inertia of the drum. At this period the spring should offer only sufficient resistance to the movement of the drum to prevent the drum from making any back lash movement at the first jerk of the string. On the other hand, at the end of the out stroke of the string, the tension may and should be higher; the string would be able to stand the higher pull, as it and the drum will have been falling in speed as the steam engine is finishing its stroke, and the higher tension of the wound up spring will enable it to the better overcome the inertia and start the drum on its backward rotation.

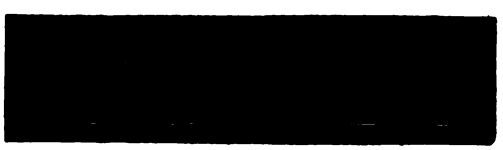

Fig. 24.

A very interesting illustration of the reality of the varying stress upon an indicator string, and therefore of the necessity of an oppositely varying tension on the drum spring, is given by the Crosby Company, as obtained by means of an instrument, the invention of Mr. G. W. Brown. This instrument is illustrated by Fig. 23, and diagrams taken by its aid, showing the variation in the tension on the string, are given in Figs. 24 to 27. If a perfectly inextensible string could be obtained, the difference of tension would make no difference in the steam diagram, and even with the good string ordinarily used there is barely any appreciable effect on the diagram. The indications are, nevertheless, more likely to be accurate when the whole indicator works smoothly than when otherwise,

Fig. 25.

so the results obtained by the instrument shown at Fig. 23 are in themselves interesting. The drum spring testing instrument consists of a wooden plate, A, to one end of which is fastened the brass frame B B, carrying the slide C with its cross head D. The head of the spring F is screwed to the cross head, while the other end is connected with the bent lever G, carrying the pencil. The connecting rod E, which moves the slide C, receives its motion from a crank not shown in the illustration. The swinging leaf holds the paper on which the diagram is to be taken. The indicator to be tested is clamped to the plate as shown, and the drum cord connected with the free end of the spring. The crank is made to move at the speed at which it is desired to test the drum and spring. The paper is then pressed up to the pencil and the diagram taken. If the strain on the cord is constant, the lines which represent the forward and return strokes will be parallel to the motion of the slide, but, if the strain is not constant the pencil will rise and fall as the strain is greater or less. The line below the diagram is the line of no stress, and is drawn when the cord has been detached from the indicator. In the diagram, horizontal distance represents the position of the drum, and vertical distance represents the strain on the cord. The perfect diagram would be two lines near together and parallel to the line of no stress, and would represent a constant stress, and consequently a constant stretch of the cord, from which no error would result.

The diagrams, Figs. 24 to 27, are shown two-thirds their original size.

Fig. 24 shows how, with a Thompson indicator drum, the stress on the string at 250 revolutions per minute fluctuated from but a slight one to a high one, falling again before the end of the stroke, when it rose to the point from which it fell, rose and fell to the starting point. Fig. 25 shows the stresses

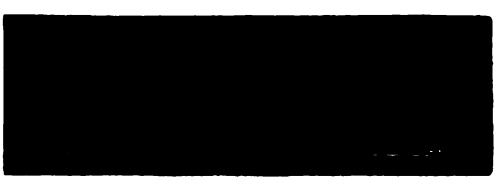

Fig. 26.

as obtained by Messrs. Crosby with their own drum spring; here the stresses become so near as to be almost a single stress. Fig. 26, also obtained by the makers themselves, is from a Tabor indicator drum at 400 revolutions per minute, while Fig. 27 is from a Crosby drum at 450 revolutions. In both Figs. 24 and 26 the straight dotted line is merely to connect the two points at the ends of the stroke, to show the departure of the stresses from a uniform rise and fall with the stroke. These diagrams have an interest from a mechanical point of view apart from indicators themselves. They serve to show how varied may be the stresses where uniformity, or approximately uniform rise or fall, might be expected.

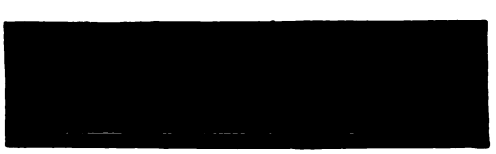

Fig. 27.

The guide pulleys seen in Figs. 20 and 21 are adjustable as to position by means of the nut below the drum, so that the string may be led in any desired direction.

The spring clips on the Crosby drum are, it will be seen, not of equal length. This is an apparently small invention, but it really is one which saves a great deal of trouble. It makes the application of the indicator paper very much easier and quicker than as ordinarily made.

In our next we shall deal with the use of the indicator.

Societe Generale des Telephones.—In the week ended 25th Dec., this company booked a dozen new subscribers in Paris; and in that ended 20th Dec., three at Havre, one at Lyons, and one at Marseilles.

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THE INDUCTION OF CURRENTS IN CORES.

BY OLIVER HEAVISIDE.

(CONCLUDED FROM PAGE 107.)

Now let a normal system of magnetic force in the cores be

$$Am_{12}J_0(n_{12}r_{12})e^{Dt},\ Am_{13}J_0(n_{13}r_{13})e^{Dt},\ \&c. \quad . \quad (139)$$

merely changing the subscripts in passing from one branch to another. Here D is the same in all. That makes it a normal system. Again, the n's are known in terms of the D, by

$$4\pi\mu_{12}D = -n_{12}^2 P_{12},\ \&c.$$

Finally, the m's in (139) are a set of ratios to be found, and A is a common factor, fixing the actual size of the system. We have also

$$\Gamma_{12} = Am_{12}J_0(n_{12}c_{12})e^{Dt}/4\pi N_{12},\ \&c. \quad . \quad (139a)$$

Inserting this expression for Γ_{12} in (138), we get, with $t=0$,

$$P_1 - P_2 = \Gamma_{12}\frac{y_{12}}{x_{12}} \quad . \quad . \quad . \quad . \quad . \quad (140)$$

where $x_{12} = J_0(n_{12}c_{12})$, and

$$y_{12} = \{[R_{12} + (L_{12} - M_{12})D]J_0(n_{12}c_{12}) - S_{12}n_{12}J_1(n_{12}c_{12})\} \quad (141),$$

as in the last section. Here y_{12} and x_{12} are constants; also (140) would be the expression of Ohm's law if y_{12}/x_{12} were the resistance of the branch 1, 2, and there were no impressed force. So all we have to do is to put $C_1=0$, $C_2=0$, &c., $P_q=0$, in equations (131), and write x_{12}/y_{12} instead of K_{12}, to get the potential equations. But, the left members being now zero, we have

$$Z = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (142)$$

necessarily. This is the determinantal equation of D, when in the full expression for Z we write x/y for K. It should be cleared of fractions to avoid missing roots. Thus, the expressions (136) equated to zero, with x/y, as defined in (141) put for every conductivity, and cleared of fractions, will be the determinantal equation when every branch in the diagram contains a coil with a core. The ratios m in (139) next have to be dug out of the potential and continuity equations. That done, there is only left the size of A to be settled. Given the state of magnetic force h in the cores, and the coil currents γ at the moment $t=0$, A is to be found by the property of the vanishing of the mutual energy of a pair of normal systems, which makes the mutual energy of the given system with respect to a normal system, as defined in (139) and (139a), with $t=0$, equal to twice the energy of the normal system itself, and gives

$$A = \frac{\Sigma\tfrac{1}{2}\mu l\int hmJ_0(nr)rdr + \Sigma(L-M)\gamma mJ_0(nc)/4\pi N}{\Sigma\tfrac{1}{2}\mu l\int m^2\{J_0(nr)\}^2rdr + \Sigma)L-M)\{mJ_0(nc)/4\pi N\}^2} \quad (143).$$

Here the Σ's indicate inclusion of all the coils, so no suffixes are written, and the integration is from the axis to the boundary in every core. With this, we leave the combination. It is not patented, and is freely given to the world, without money and without price.

ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

Conductivity, Capacity, and Permeability.

In the electromagnetic scheme of Maxwell there are recognised to be three distinct properties of a body considered with reference to electric force and magnetic force, viz., conductivity, electrostatic capacity, and magnetic permeability. The body may support a conduction current, it may support electric displacement, and it may support magnetic induction. These three phenomena may, and in general do, coexist at any one point. Quantitatively considered, they are all vector magnitudes, having definite directions as well as strengths, which are reckoned per unit area perpendicular to their directions in terms of chosen units.

The facility of supporting the three states of conduction current, electric displacement and magnetic induction varying with the nature of the medium for equal amounts of energy concerned, brings in three coefficients, the electric conductivity k, the electric capacity c, and the magnetic permeability μ. At first sight it might appear as if three other vector magnitudes related to the former by these coefficients were involved; but in reality there are but two, the electric force and the magnetic force, the former being connected with both the conduction current and the displacement.

First we have Ohm's law. C being the conduction current density, E the electric force, and k the specific conductivity,

$$C = kE \quad . \quad . \quad . \quad \text{(Conduction current)} \quad . \quad . \quad . \quad (1)$$

Far more is known about conductivity than about capacity or permeability. In an unstrained isotropic metal, k appears to depend on the temperature only, and not to vary rapidly with it. That is, k is practically a constant, which simplicity is of great utility. Within wide limits k is independent of the current or the electric force.

The range of conductivity in different media is very great. From the conductivity of copper to that of cold glass is such an enormous range as to compare with astronomical ratios, and it speaks well for electrical science that it can compare definitely such widely differing magnitudes. But why be satisfied with copper? The discovery of a well-stocked mine of a material possessing, with other necessary qualities, a conductivity say ten times that of copper, would effect a revolution in the practical applications of electricity. Let it be looked for. There is a fortune in it, when found. There is some reason to believe that there are many of these mines in Spain; probably, though this is uncertain, in the neighbourhood of the old castles.

Dry air in its ordinary state appears to have no conductivity. But it is a vacuum that is the perfect non-conductor in Maxwell's theory. Where there is no matter, in the ordinary sense, there is no dissipation of energy; and ether, whatever it be, is perfectly conservative and non-dissipative, dynamically considered. Dissipation of energy is a necessary accompaniment of a conduction current, so far as is known; though of course a perfect conductor can be imagined in which a continuous current developed no heat. But ether cannot be this perfect conductor consistently with the propagation of magnetic disturbances, for none can be propagated in a perfect conductor. Grant that they are propagated in pure ether (space from which all "matter" has been removed) without loss of energy in the medium, and it follows that ether is the perfect non-conductor. This, however, somewhat anticipates electric displacement and magnetic induction.

Equation (1) is a vector equation. In an isotropic medium k is a scalar constant. We may symbolise E, C, or other physical vector magnitudes by geometrical vectors, lines drawn of the proper lengths and in the proper directions. Thus E is one vector, C is another, and when, as ordinarily, k is a scalar constant, (1) says simply that C and E are parallel, and that C is k times as long as E. Vector quantities are compounded like velocities; in a vector equation containing n vectors, separated by + or − signs, the n vectors form the n sides of a polygon. But two straight lines cannot enclose a space, so in equation (1) C and kE are parallel and equal.

But in a body eolotropic as regards conductivity, C and E are only exceptionally parallel. Using the same equation (1) to represent the relation between them, k, from being a scalar constant, becomes a linear vector operator; kE must be regarded as a single symbol, being E operated upon by k in a certain manner, turning it into a new vector kE. The operation is a little complex when expressed in Cartesian co-ordinates referred to any axes, so it is better to define once for all the meaning to be attached to k when eolotropy is to be included, and then use equation (1), rather than be repeating the Cartesian operations over and over again. The following defines the operation k, and the same will serve for c and μ later. First let there be no rotatory power. Then in three directions, mutually perpendicular, fixed in the body at the point considered, depending on

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its structure there, Ohm's law, isotropically considered, is obeyed. That is to say, if electric forces E_1, E_2, E_3 act successively parallel to the above mentioned directions, or principal axes of conductivity, and C_1, C_2, C_3 be the corresponding currents, C_1 will be parallel to E_1, C_2 to E_2, and C_3 to E_3, and we shall have

$$C_1 = k_1 E_1, \quad E_2 = k_2 E_2, \quad C_3 = k_3 E_3, \quad . \quad . \quad . \quad . \quad (2)$$

where k_1, k_2, k_3 are scalar constants, being the principal conductivities. From this we find the current when the force acts in any other direction than parallel to one of the principal axes. For if E be the force, let its components parallel to the axes be E_1, E_2, E_3; the components of the current will then be C_1, C_2, C_3, as defined by (2). Compounding them, we get C. Thus the relation of C to E requires a knowledge of the principal conductivities and the directions of the principal axes.

But should the body possess rotatory power, the above process is incomplete. Let ϵ be a vector, directed parallel to the conductivity axis of rotation, and of length properly chosen, then to the current as found by the above process must be added another current expressed by

$$V\epsilon E, \quad . \quad . \quad \text{(Vector product.)} \quad . \quad . \quad (3)$$

which stands for a vector whose direction is perpendicular to the plane containing ϵ and E, and whose length equals the product of the length of ϵ into that of E, into the sine of the angle between their directions. This also defines the prefix V before two vectors. The + direction is defined thus. Let ϵ and E be the short and the long hands of a watch. Let ϵ point to XII. and E anywhere else. The angle between ϵ and E is measured positive in the usual direction of motion of the hands, and the direction of $V\epsilon E$ when positive is from the face to the back.

It is possible, consistent with the linear principle, for k_1, k_2, k_3 to be all zero, and ϵ not zero. Then

$$C = V\epsilon E$$

simply; the current is always perpendicular to the force, of maximum strength when ϵ and E are perpendicular, and vanishing when they are parallel.

Returning to equation (1). Multiply by E. Then

$$EC = Ek E = Q \text{ say}, \quad . \quad . \quad \text{(Dissipativity)} \quad . \quad . \quad . \quad (4)$$

Q is the dissipativity per unit volume. It is in the first place the rate of working of the force E, and next, by the experimental law of Joule, the rate of generation of heat per unit volume. (4) is a scalar equation. All our equations will be either wholly scalar or wholly vector. In case of isotropy, with k a scalar constant, we may write $Q = kE^2$; or, since $E = k^{-1}C$, $Q = k^{-1}C^2$, where k^{-1} is the specific resistance, a more familiar form of Joule's law. But in general, when k is a linear vector operator, we must not take $Ek E = kE^2$, unless E act parallel to one of the principal axes, when we may do so, with the appropriate value of k for that axis. When E and C are not parallel, the product EC means the strength of E multiplied by that of C, and by the cosine of the angle between their directions, which of course includes the common algebraic meaning of EC, since when E and C *are* parallel, $\cos 0^\circ = 1$. Referred to three rectangular axes, if E_1, E_2, E_3 are the compounds of E, and C_1, C_2, C_3 those of C, then

$$EC = E_1C_1 + E_2C_2 + E_3C_3 \text{ (Scalar product)} \quad . \quad (5)$$

which is an equivalent definition of EC.

Coming next to specific capacity, although there are media, as air, which appear to have no conductivity, yet, by the continuity of the electric current, they can support current; not steady, but transient, and stopped elastically. By an obvious mechanical analogy the integral current is termed the electric displacement. Let this be D, and let E, as before, be the electric force. We have then

$$D = \frac{1}{4\pi} cE \text{ (Electric displacement)}. \quad . \quad . \quad (6)$$

The excrescence 4π is a mere question of units, and need not be discussed here. The 4π's are particularly obnoxious and misleading in the theory of magnetism. Privately I use units which get rid of them completely, and then, for publication, liberally season with 4π's to suit the taste of B.A. unit-fed readers. Of course, if it comes to numerical comparisons we should have to consider the ratios of units in the ordinary to what I may call the rational system. Sometimes it is $\sqrt{4\pi}$, sometimes $(4\pi)^{-\frac{1}{2}}$, sometimes 4π, sometimes unity, but in the mere algebra it is simply a matter of putting in 4π's here and there in translating from rational to ordinary units.

In a dielectric medium, the force and the displacement are simultaneous, like the force and the current in a conductor. Time does not appear in the equations. In an isotropic dielectric, c is simply a scalar constant; in an eolotropic dielectric it is, as described above for k, a linear vector operator, with this difference however, that there is no rotatory vector ϵ, so that the relation of D to E is settled by the values of the principal capacities, and their axes.

Multiply (6) by $\frac{1}{2}$E; then

$$\tfrac{1}{2}ED = \frac{1}{8\pi} EcE = U, \text{ say.} \quad \text{(Static energy)} \quad . \quad . \quad (7)$$

U is the electrostatic energy per unit volume, the work done by the force on the displacements as they rise from 0 to their final values, or the final displacement multiplied by the mean force which produced it. This energy is stored, and is recoverable in work like the energy of a perfectly elastic strained spring. It is unnecessary to assume that there is any real displacement of anything in the direction of the electric displacement. All the electric and magnetic quantities are more or less abstractions, measurable abstractions, whose real signification is as yet unknown.

Far less is known of c than of k, and it is not so agreeably definite as k. Solid dielectrics appear to have imperfect electric elasticity, as they have imperfect mechanical elasticity. The bent spring, with the applied force removed, and brought quietly to rest, is not exactly in its equilibrium position. A small part of the displacement remains, and slowly disappears. This is easily shown when not visible to the eye by using a microphonic contact; though, by the way, the variability of the contact itself makes it a bad method. Most likely there is no such thing as a perfect return even with small displacements; we cannot draw a hard and fast line to mark the limit of perfect elasticity.

All non-conductors are dielectric. Bad conductors are also dielectric. Good conductors, even the best, may be dielectric as well, so that with a force E we shall have a conduction current kE and a displacement $(4\pi)^{-1}c$E co-existing. But in such case, as well as in the case of known dielectric power of bad conductors, kE is not the complete or true current, unless the displacement remains steady. The time variation of the displacement is itself an electric current, and the true current is the sum of the conduction current and of the rate of increase of the displacement. Let Γ be the true current, we have, in a conducting dielectric, or dielectric conductor,

$$C = kE, \qquad D = \frac{1}{4\pi} cE,$$

$$\Gamma = C + \dot{D} = kE + \frac{1}{4\pi} cE, \quad . \quad . \quad . \quad \text{(True current)}. \quad . \quad (8).$$

Put $c = 0$ in a pure conductor, and $k = 0$ in a pure dielectric. It is the true current that is 'the current" when we come to induction and variable states.

In the equation $\Gamma = C + \dot{D}$ we have three vectors. They form the three sides of a triangle, unless $\dot{D}$ should be parallel to C. But $\dot{D}$ may not be parallel to C, nor need it be parallel to D. If we charge a condenser formed of two large flat opposed conductors very close together, the displacement current, when setting up the displacement, is, by general reasoning, parallel to the displacement—at least away from the edges. But this is not invariable. When charged conductors are discharged, the displacement current does not in general follow the tubes of displacement. To do so would require instantaneous propagation of the disturbance to infinite distances. The displacement current may be perpendicular to the displacement—viz., when the displacement at a certain place changes its direction without changing in amount.

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Multiply (8) by E; then

$$E\Gamma = Ek E + \frac{1}{4\pi} Ec\dot{E} = Q + \dot{U} \quad . \quad . \quad . \quad . \quad (9).$$

The rate of working of the force is accounted for partly in heating (Q per second), and partly in the increase in the energy U of the displacement. (Equations (4) and (7)). The first is lost from the system, the latter is stored.

Whilst conductivity depends on the presence of matter, the existence of capacity is independent of matter, though modified in amount by its presence. That is, capacity is a function of the ether, which is the standard dielectric medium of least capacity. Ether is a very wonderful thing. It may exist only in the imaginations of the wise, being invented and endowed with properties to suit their hypotheses; but we cannot do without it. How is energy to be transmitted through space without a medium? Yet, on the other hand, gravity appears to be independent of time. Perhaps this is an illusion. But admitting the ether to propagate gravity instantaneously, it must have wonderful properties, unlike anything we know. Similarly in the propagation of the transverse vibrations of light, it is not easy to conceive ether acting as an elastic solid. We may know some day. But if not, what matter? Things will go on all the same whether we know how it is done or not. What vanity is this the philosophers are striving after? Is it not "Science, falsely so called," when there is the infinite blank of the Unknowable behind? And, speaking of blanks, might there not be a great blank in space, to which we shall arrive some day, to find all theories confuted?

Coming next to permeability, all bodies sustain magnetic induction, and most of them to nearly the same degree. H being the magnetic force, B the induction, and μ the permeability,

$$B = \mu H \quad . \quad . \text{ (Magnetic Induction) } . \quad . \quad (10).$$

μ is taken as unity in ether (in the electromagnetic system), and is either a little greater or a little less in most bodies. But in some bodies it, very singularly, runs up to large numbers. Iron is the principal offender; then come nickel and cobalt, minor magnetics, but far removed from the crowd of almost unmagnetisable substances. Fe = 56, Ni and Co about 58·5. What can it be?

The linear connection between H and B is very unsatisfactory. Not merely does μ vary with the temperature, and enormously from one piece of iron to another, being, with moderate strength of magnetic force largest in the softest iron and smallest in hard steel, but it varies with the magnetic force, first increasing with the force, and then, more importantly, decreasing greatly; how far down is unknown. To make matters worse, part of the induction produced by applied magnetising force becomes fixed, for the time, remaining after the removal of the force. Thus the linear connection between H and B must be taken with salt. But within moderate limits, and excluding permanent magnetisation, which requires separate consideration, μ in equation (10) may be taken to be, like k and c before, a scalar constant in case of isotropy, and a linear vector operator in eolotropic media, being then, like c, self-conjugate, or without the rotatory power.

μ in soft iron is said to run up to 5,000 or 10,000 (Rowland's experiments. I forget the exact figures). But in general it is very far lower than these tremendous figures. From experiments on the retardations of coils made some years ago, including straight solenoids, I concluded that μ = from 50 to 200 was safe.

Not B, but $B/4\pi$ should be the magnetic induction to compare with D, the electric induction, or displacement. So, dividing (11) by 4π, and then multiplying by $\frac{1}{2}H$, we have

$$\tfrac{1}{2}H\frac{B}{4\pi} = \frac{1}{8\pi}H\mu H = T, \text{ say, } . \text{ (Magnetic energy) } . \quad (11).$$

T is the energy of the magnetic induction per unit volume, when wholly induced, and acting conservatively.

(TO BE CONTINUED.)

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The remarks of Professor Dolbear, quoted p. 125, are no doubt an interesting attempt to elucidate a very important matter, but some portion of them really appears to be very wide of the mark. I refer to the effects attributed to the discharge from a Holtz machine, which is estimated to produce through a wire a current of 50 million amperes, which is supposed to produce no apparent effect, because its duration is probably less than one millionth of a second. I think both the estimate and the explanation are erroneous. The power of a current to destroy a wire is not limited to the calculated energy carried by the current. We cannot say that the wire could not be vaporised or melted unless that energy represented the heat needed for those results. The molecular motions involved in the passage of the current may disintegrate the metal and reduce it to its ultimate molecules, even though the heat equivalent were far below that required to fuse the metal; in fact, a metal carrying a current and fused by it does melt at a point considerably below its temperature of fusion, when this is a consequence of heat. Of course this is assuming the possibility of a large current passing for an infinitesimal period without the energy corresponding to it under ordinary conditions, an assumption we have no right to make. But Professor Dolbear's actual figures bring out a very different result, for 50 million amperes with an E.M.F. of 50,000 volts for, say, 1 millionth of a second is $\frac{5\cdot\times10^7\times5\times10^4}{1\cdot\times10^6} = 25\times10^5$, or two and a half million joules. This amount of energy would cause a large conductor to vanish away, and its conversion would require a Holtz machine of somewhat unusual dimensions.

But what is the current we might look for from a Holtz machine, or rather from its discharge? Say its potential E is, as stated, 50,000 volts, and the resistance of the wire ohm ·001, is it proper to employ Ohm's formula to estimate the resulting current? Is $\frac{50{,}000}{\cdot001} = 50{,}000{,}000$ a correct consequence of the conditions? Professor Dolbear has neglected the very caution he gives as to the need for considering quantity as well as E.M.F. We know that a Holtz machine gives only an infinitesimal current, because its own internal resistance is so vast. Therefore the conditions considered involve the discharge of an accumulation, as in a spark; and it is necessary to take into account not only the potential of the discharge and the resistance it is to traverse, but also the *quantity available to pass as a current*. If we neglect this we must take into account not only the resistance of the conductor, but also that of the machine, or the condenser holding the charge, and then we get among the megohms, which will vastly reduce the Professor's result.

The actual quantity in such a discharge is probably not easy to ascertain, but a very rough calculation will serve the purpose. Taking the electrostatic system, we may consider that the balls of the conductor have unit capacity, that of a sphere of one centimetre radius, and then if we take 60,000 volts (to save fractions and 3×10^{10}) as the ratio of r, we find that the quantity is about two-millionths of a coulomb. Now, if we take the period of discharge at the highest estimated, viz., one-millionth of a second, and suppose the current uniform, we have a current of 2 amperes instead of 50 millions. Or if we consider that the capacity of the whole system of balls and jars is one microfarad, then with an E.M.F. of 50,000 volts we get only one thousandth of the current stated. The Holtz machines have generally but a very small fraction of a microfarad capacity, so that we come to something like the first result, viz., that the amperes of current so produced must be reckoned by units, and probably far below one ampere instead of by millions.

The calculations as to the current and energy which may traverse the human body are subject to similar corrections of errors caused by the slavish use of Ohm's formulæ without considering the natural parts. The resistance from hand to

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hand of the human body ranges under ordinary conditions from 5,000 to 10,000 ohms, but this is when measured with small battery power and when grasping good conducting handles. This is entirely different from the accidental contact of a small surface, and that probably at only one point instead of two. It is of little use to reckon up possible amperes of current and consequent horse-powers traversing the body under conditions so entirely different. Then, also, the resistance of the body, with other conditions alike, would not be the same with currents of milli-amperes as usual, and of several amperes as estimated. We know from Edison's motograph that great changes instantly result from the generation of gases. Now the instant effect of the commencement of a large current would be the production of an external film of gas, and a superficially changed surface, due to the action of nascent acids and alkalies in the skin. There is no likelihood of the generation of gases within the body.

The real danger would appear to have little to do with such calculations of current; it is due to a physiological effect of the static actions which accompany the setting up of the difference of electric potential; it is the sudden and violent contraction which occurs in all the muscles traversed, and the nervous derangement due either directly to the molecular motion set up in the matter of the nerves in the setting up of electric stress, or else indirectly to the effect of pain and fear, or, in the usual phrase, nervous shock. This is why our electromotive force, which is absolutely harmless when sustained and producing current, may be dangerous and even fatal in the alternating form which repeats shock after shock, and, by setting up rapid molecular motions in the organism, destroys its proper vital action. This indicates the importance of perfect insulation, and such separation of conductors as to avoid risk of getting the body into the circuit.—Yours, &c.,

J. T. SPRAGUE.

THE ELECTRIC LIGHTING ACT COMMITTEE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the letter from Mr. H. F. Jool, which appears in your last issue, may I be permitted to point out that the premises upon which that gentleman bases his arguments can scarcely be considered as being in accordance with the facts. From Mr. Joel's statements it is to be inferred that the committee of which Lord Thurlow is chairman is controlled by the Anglo-American Brush Electric Light Corporation and the Edison and Swan United Electric Light Company, and that all the members of the Executive "belong to, or are connected with, one or the other of the two companies before mentioned," and that "in its present form the Executive Committee only speaks for the two companies, and only represents company interests." How far this statement is correct can be determined by reference to the list of members of this committee, which has already appeared in extenso in *The Electrician*, and from which it will be seen that the committee consists at present of 45 members, of whom only 13 are, so far as I know, either directly or indirectly connected with the two above-mentioned companies; that, out of about 20 English electric lighting companies to be found in the Directory, about 15 are represented on the committee; that several private electric lighting firms (like Messrs. Crompton) are represented; and that among the members are one of the vice-presidents of the Institution of Civil Engineers, one of the vice-presidents of the Society of Telegraph-Engineers and Electricians, and many of the foremost scientific and legal authorities upon the subject of electric lighting legislation. The Executive Committee was appointed from the full list of members by ballot at a representative meeting of this committee, and consists of ten members, two of whom are associated with the Anglo-American Brush Corporation, two with the Edison and Swan Company, one with the Hammond Company, and one with the Electrical Power Storage Company, the four remaining members being Sir Frederick Bramwell, Mr. R. Campbell, Mr. R. E. Crompton, and Captain Douglas Galton, C.B.

I merely wish to add that the formation of this general committee is only one more step in the progress which a combination of electric lighting companies and others had already made in the direction of reform in the interests of the industry generally, and is the immediate result of the interview which they had with the President of the Board of Trade a few weeks back. This committee has already, therefore (apart from its influential and representative character), a *locus standi* which will add weight to its deliberations, and doubtless secure for its decision the especial consideration of the Board of Trade.—Yours, &c.,

C. GARCKE,
Hon. Sec. to the Committee.

Belvedere road, Lambeth, London, 31st Dec., 1884.

HEATING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of last week mention is made of experiments carried on in France for heating railway carriages with electricity. Heating by electricity has not as yet attracted the attention which so important a subject would seem to merit, and it may, therefore, interest your readers to know that since October, 1883, I have successfully warmed some of the smaller rooms of my house with a very simple apparatus, as described in my patent, "Electrical Heating," No. 4961, 1883 (some of the forms of which are specially designed for railway carriage warming). In heating rooms by this means there is the great additional advantage that a current of fresh air from the exterior can be passed through the electrical heater, so as to enter the room at any desired temperature within moderate limits. The outside air being, say, at freezing point, can enter the room fresh and pure at a temperature of 200deg., causing thorough ventilation, a matter of no small importance for sick rooms or hospitals. A modified form is used nightly in my house as a bed warmer, the heat being turned on or off at the bedside at any required moment, a great convenience for invalids. As a minor use I also employ the same principle for a chicken incubator, and it is especially applicable to the French system of "thermostatic" nursing, avoiding the noxious fumes of the gas or oil at present employed.

An ordinary foot warmer for railway carriages is a very simple adaptation of the same principle, but if desired, fresh warmed air can be admitted, and the temperature of any closed carriage be regulated by the form used for chamber heating. When once the electric current is furnished to railway carriages for lighting purposes, which cannot be long delayed, this will doubtless prove to be a very convenient and cheap method for heating them. If the arrangement is fitted to permanent receptacles containing salts, such as acetate of soda, the heating of carriages can be carried out with still greater facility and convenience, and at a very low cost.

I shall be happy at any convenient occasion to show you some forms of the apparatus at work.

With the further exception of the system patented by Mr. Oswald Rose, in May, 1882, I have no knowledge of any other attempt to deal practically with the subject.—Yours, &c.,

JOHN S. SELLON.

The Hall, Sydenham, Dec. 30, 1884.

FLUORESCENCE OR PHOSPHORESCENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is well known that fluorescence or phosphorescence is common to a great many substances, viz., certain varieties of fluor spar, glass coloured by peroxide of uranium, red seaweed of different kinds, &c., but the cause of this phenomenon is still a matter of doubt to many. It is believed by Professor Stokes that the explanation of fluorescence lies in the communication of motion by means of the intermolecular forces, from the molecules or part of a molecule thrown into agitation by the vibrating ether, to the neighbouring parts, and thence to the mass in general.

The following experiment appears to agree with the above explanation of Professor Stokes:—By holding a partially exhausted incandescent lamp in one hand and rubbing it with

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the other until it becomes warm, beautiful phosphorescent effects may be produced. Of course, these effects are best seen if the experiment be performed in a dark room. After being rubbed, if the lamp be tapped by the finger fluorescent effects will be produced almost as bright as in the former case. The friction thus produced by rubbing and the vibration by tapping appear to be the cause of fluorescence in this case. If the vacuum be either very good or very bad these effects will be produced with difficulty; if the vacuum be entirely destroyed, no effects will be observable.

We may conclude from the foregoing that the vacuum of incandescent lamps may be roughly tested in this manner.—Yours, &c., JOHN B. DUNCAN.

16, Brandling-place, Newcastle-on-Tyne, Dec. 22, 1884.

SECONDARY BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On December 20th you published an article on the electrical tram car recently built by the Storage Company, in which you gave certain figures as to the depreciation of the cells which are likely to be misleading.

You say that owing to a new design lately introduced the useful output for a given weight has been increased without in any way sacrificing the *durability;* and later, that Mr. Reckenzaun has based his figures for working cost on a depreciation of 50 per cent. as a safe limit. This would naturally imply that the cells used for lighting purposes would depreciate in the same ratio, which is far from being the case.

The type of plate manufactured by the Storage Company enables the conductor and the active material to be disposed to the best advantage, but the proportions are varied according to requirements.

The accumulators supplied for lighting purposes are made with a view to obtaining great durability coupled with a high effective return, whereas in the tram car cells the first consideration is a rapid discharge from a minimum weight.

In the latter case the metal is distributed where most needed, but the same durability cannot be expected as with cells designed for lighting or other purposes where weight is of minor importance.

We have every reason to hope, however, that Mr. Reckenzaun's allowance for depreciation will be more than ample, as the cells which were first made have been in constant use for over three months, and show no signs of deterioration.

It is impossible to say definitely what the life will be of the plates manufactured for lighting purposes with the latest improvements, but it may be mentioned that even with the older types the positives frequently lasted 18 months, and there is little doubt that this will be exceeded with the plates now being supplied.

The depreciation is confined almost entirely to the positives, and the company have already made arrangements to meet their customers in this respect by quoting a special price for renewal plates.—Yours, &c.,

BERNARD DRAKE,
Managing Engineer, Electrical Power Storage Company.

FUSIBLE OR AUTOMATIC CUT-OUTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having read the description of Mr. Cunynghame's ingenious automatic cut-out, and noticed your remarks on the failure of Messrs. Woodhouse and Rawson's fusible cut-outs, may I be allowed to say a few words on this subject? It is stated that "fusible cut-outs are objectionable," firstly, because of "loss of power and change of melting point through heating." Is not this paradoxical? for the reason that loss of power means increased resistance; while on the contrary it is the lowered resistance, produced by the deterioration of the alloy, which causes the fuse to go at a lower temperature. The second objection is, that "it is impossible to test each plug, and often considerable variation is found." This I can account for if the arrangement was as described—namely, "foil fastened on fibre." How can it be otherwise, as there are two opposing forces, the expansion of the foil, due to the rise in temperature, resisted by non-expanding vulcanised fibre? My experience is, that if the foils are clamped at their two ends only, and allowed to expand freely all along their length, not only are they absolutely reliable, but the current at which a number fuse will not vary more than 2 per cent.; and if the material employed is suitable no change of melting point will be noticed. The automatic cut-out has its uses, but as a rule, if untouched for a length of time, is generally found to stick so that it will not pull; besides, what is there to prevent the man in charge of an installation from increasing the current by manipulating the instrument, and thus shorten the life of the lamps?

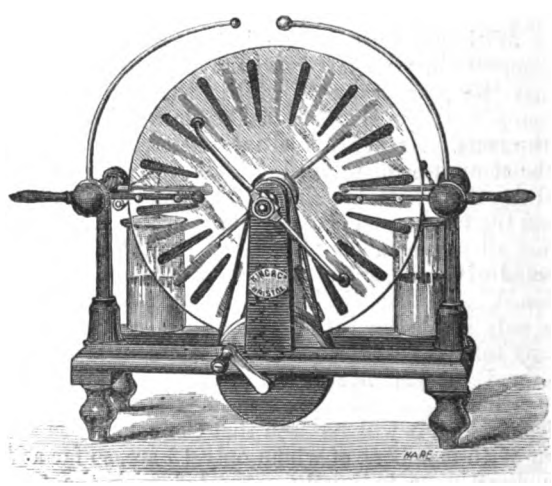
I do not think the increased resistance of fusible cut-outs when heated would be found of any great importance, and certainly not more than the resistance of the coil of the electro-magnet, and that of the copper legs in the mercury cup after they have been in use some time and become dirty. As to the risk of employing mercury in an apparatus where there is just a chance of an arc being formed I will say nothing, but only state that I should decline to sleep in a room where the electric circuits were protected by an instrument which might possibly cause similar disastrous consequences to those which were fatal to the inventor of the mercurial electric light.—Yours, &c., KILLINGWORTH HEDGES.

25, Queen Anne's-gate, S.W.

THE WIMSHURST MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your correspondent Colonel Knipe has directed attention to what he calls a "grave error" in the description of the Wimshurst machine given in our new catalogue, which you were good enough to notice in your issue of the 13th inst.



The supposed error at once vanishes when it is understood that the *wire brushes* which we state collect electricity from the plates are not those wire brushes at the extremities of the curved rods which, as your correspondent truly observes, "only put two opposite strips of brass on the same diameter in electrical connection;" but the brushes to which we refer are those which we fit on the forked conductors, or collecting combs, to which the movable electrodes are attached.

We have found that if, in addition to the spikes on the collecting combs, wire brushes be fixed, the machine is rendered more efficient.

This arrangement constitutes one of several improvements we have made in these machines.

The position of the curved rods is shown in the accompanying illustration, which also shows the general arrangement of conductors, electrodes, &c. It was not our intention when compiling our catalogue to give a *full* account of the way in which electricity is generated in these remarkable machines,

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for we have already done this in a circular, which may be obtained from us on application.—Yours, &c.,

KING, MENDHAM AND CO.

Western Electrical Works, Bristol,
December 29, 1884.

BERTHOUD-BOREL CABLE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of 29th November you mention the gutta percha covered cables which have been laid down in the Arlberg Tunnel. In addition to these seven miles of our No. 25 Berthoud-Borel cable were laid, consisting of three conductors, each of 7 strands of No. 22 B.W.G. After the laying of our cable it was tested and found to have an insulation of 7,000 to 8,000 megohms per kilometre for each conductor. The cable was delivered in lengths of 1,000 metres, so that there were 10 joints. Tests were made after the jointing and laying of each length, and it was found that the insulation per kilometre remained the same after each joint. Since then a further order has been received from the Austrian Government for six and a quarter miles of our No. 3 cable, consisting of one conductor of 7 strands of half a millimetre diameter. This particular cable is largely used by the French Ministry of War.

With regard to our cables now being laid under the Greenock Provisional Order, it may interest you to know the results of the insulation tests made on the cables before leaving the factory. It was specified that the cables should have an insulation resistance of not less than 1,000 megohms per mile at ordinary temperature. The actual results obtained when tested under water were:—

1,925 metres of cable of one strand of 1·2 millimetre diameter, 25,000 megohms per kilometre.
457 metres of cable of 36 strands of 1·5 millimetre diameter, 6,500 megohms per kilometre.
465 metres of cable of 36 strands of 1·5 millimetre diameter, 6,800 megohms per kilometre.
582 metres of cable of 12 strands of 1·6 millimetre diameter, 12,500 megohms per kilometre.
584 metres of cable of 12 strands of 1·6 millimetre diameter, 12,500 megohms per kilometre.

The insulation given is therefore from 3½ to 15½ times better than what was asked for.—Yours, &c.,

H. BOISSELIER,
For the Kinetic Engineering Company.

London, Dec. 30, 1884.

A BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or any of your correspondents tell me how to make up a battery (not Grove or Bunsen) that will run an incandescent 2½ candle-power lamp for six or seven hours *full power*?—Yours, &c.,

H. ANDREWS.

7, Newark-street, Reading, December 29, 1884.

PAYING FOR SPECIFICATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having read the recent correspondence published in *The Electrician* upon this subject, kindly permit us to state that it has been in no way an innovation on the part of Messrs. Mackenzie and Brougham charging for the specifications and drawings in connection with the Grosvenor Gallery electric lighting contract, so far as the engineering portion of the work is concerned, in substantiation of which we beg to enclose you various cuttings from *The Engineer* and *Engineering*, inviting tenders from some of the leading public companies and engineers, in every instance of which a charge is made for the specifications and drawings, and in no case is it stated that the fee will be returned, but in several cases you will perceive it is distinctly mentioned that the fee will *not* be refunded.

We send you this communication as we consider from our experience that the engineers in question were certainly only acting upon a usual precedent in the course they adopted.—Yours, &c.,

MARSHALL, SONS AND CO. (Limited).

Gainsborough, Dec. 23, 1884.

(For continuation of Correspondence on this subject see p. 165.)

ALCIDE LUDOVIC TERNANT.

It is with much regret that we have to announce the death at Marseilles on Saturday last, after a short illness, of Mr. Alcide Ludovic Ternant, manager of the Eastern Telegraph Company's establishment at Marseilles, at the age of fifty-two. The late Mr. Ternant was born in Arras (France) in 1832. The son of an inspector of public instruction, he was educated in the Lycées of Tours and Cahors, wherefrom, after taking his degrees, he was appointed as Professor to the Lycée of Moulins. He left, however, his professorship to join the French telegraph service in 1853, and taking a special interest in submarine telegraphy, he sought and obtained a situation in the service of the Mediterranean Telegraph Company. He was sent from there to Cagliari in connection with the first cables laid from there to Bona and Malta. After a few years spent in the Persian Gulf Mr. Ternant came to England, where he devoted himself to the study of cable testing and engineering at Silvertown and Woolwich. He was for some years Mr. Henley's electrician, and in that capacity took part in several cable expeditions. In 1870 he joined the Eastern Telegraph Company as their manager and electrician at Marseilles, where till his decease he had been acting as the company's representative. Although a staunch Frenchman, Mr. Ternant was considered as thoroughly Anglicised in the telegraph service, and had done much to benefit his country by introducing English practice in French telegraphy. The telegraphic international service requires men of his stamp, and in this respect it may be said that he was the right man in the right place. Locally Mr. Ternant gained the confidence and respect of his countrymen, who daily consulted him on the practical applications of electricity. He was lately elected president of the Société Scientifique Industrielle, and also of the Société de Statistique of Marseilles. Mr. Ternant was the first in France who studied in scientific papers the laws of the propagation of the electric current in submarine cables, and he had published several important papers on this subject in the *Journal des Télégraphes* and the *Annales Industrielles*. He had also published several interesting works on the telegraph and the telephone, which are consulted daily by those interested in these matters. His kindly and aimable disposition endeared him to all his friends and colleagues, who sincerely mourn his lamented death. His funeral took place at Marseilles on Monday, and his remains were followed to their last resting place by a large and influential number of friends, among others, Mr. Duportal, director of the French Government Telegraphs; Mr. Bebz, engineer of Government Telegraphs; Mr. Lawton, assistant superintendent, Eastern Telegraph Company, several representatives of the local scientific and financial societies, and many others.

ELECTRIC LIGHTING AT VIENNA.—It has been decided to light the Imperial Palace, the Court Opera House, and the Burg Theatre of Vienna by electricity. The palace will be illuminated with 5,000 lights, the Opera House with 4,000, and the Burg Theatre with 3,000. The system to be employed is the Turettini patent, and the contractors are the Vienna Gas Company. The new Parliament House and the University will, in all probability, also be lighted electrically.

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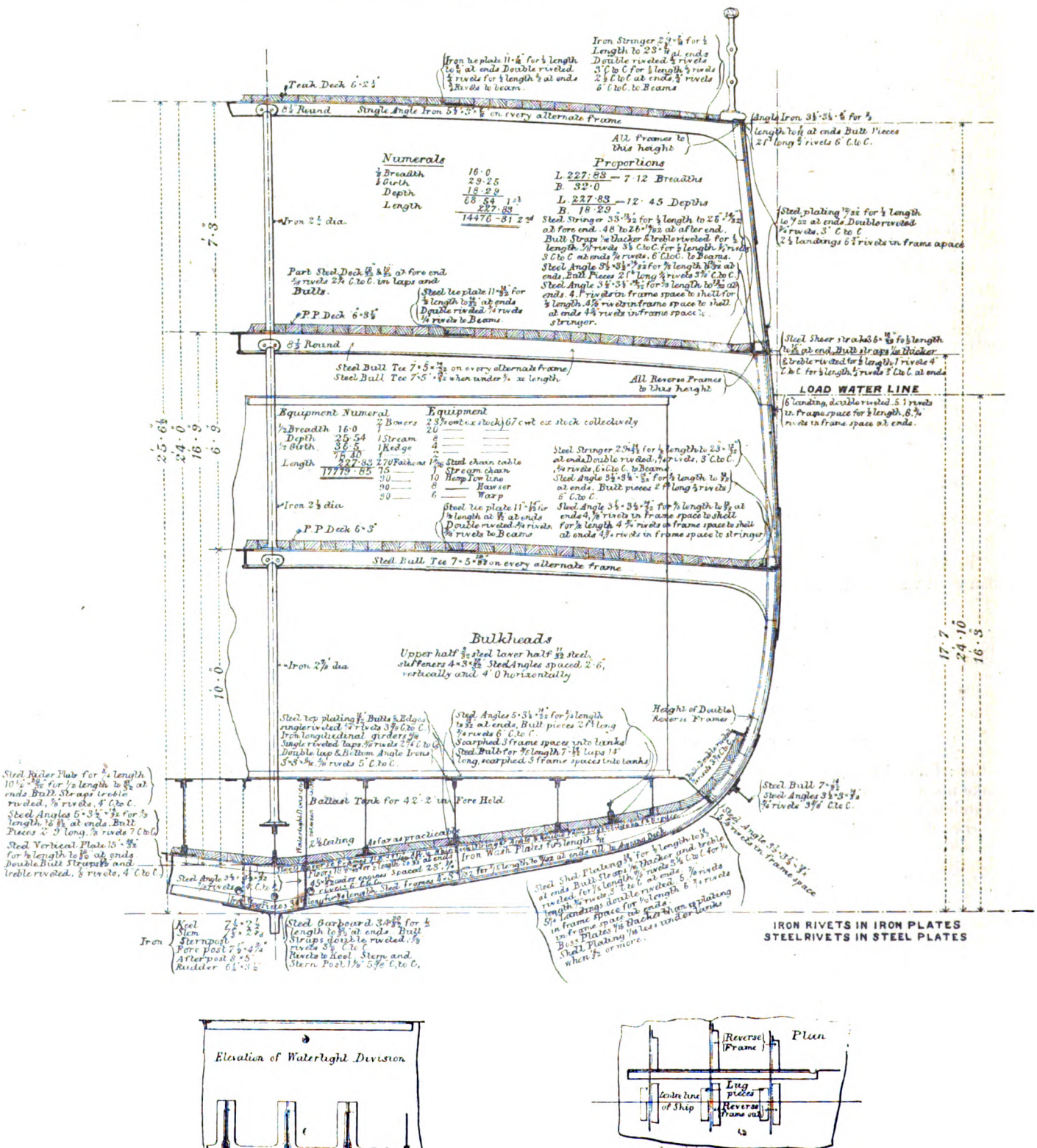
THE NEW CABLE STEAM-SHIP "THE MAGNETA."

Midship Section of a Steel Screw Steamer for Cable Purposes to Class 100 A. Awning Deck Special Survey

Dimensions

Length (between perpendiculars)	230'-0"	
Breadth (moulded	32'-0"	
Depth (do) to Main Deck	17'-7"	
Do (do) to Awning Deck	24'-10"	



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In a note in a previous issue the launch of a new cable ship was recorded. We commence in this issue to give various details of the ship—details which, so far as we know, have never before been published. Ships have before now been specially built for cable work, but we do not hesitate to say that never before in the history of submarine telegraphy has so complete a specification been prepared for the building and fitting of cable ships as those prepared for the "Magneta" and a somewhat similar vessel the "Electra." The "Magneta" has been built and engined by Messrs. Napier, of Glasgow, to the order of the Eastern Extension, Australasia and China Telegraph Company, from the design of Mr. Joseph Birnie. The ship, as soon as ready, will be sent to the Singapore station, and is therefore fitted for work in a tropical climate. It is hardly necessary to dwell at length upon the engravings which are given in this issue, inasmuch as they almost explain themselves. Before entering upon the description of the vessel we must congratulate the cable world, and the share holders of the Eastern Extension Company in particular, upon the acquisition of so fine an addition to their fleet. We have often said that submarine telegraphy is of modern growth. It is the work of men who are still among us—working as earnestly, as laboriously as in the days of yore, encircling the world in a network of wire, laying hold of scientific discoveries and fashioning them into weapons to wield for the benefit of civilisation. Their experience has been called upon in the production of these ships, with the result of obtaining an almost perfect equipment for the work.

The "Magneta" has the following dimensions:—	Ft.	in.
Length between perpendiculars	230	0
Beam	32	0
Depth of hold, top of floors to top of main deck beam	16	9
Depth, top of floors to top of awning deck	24	0

Tonnage (B.M.), about 1,096 tons.

The ship is intended to steam 11 knots while working on a consumption of 14 tons of coal per day, and carries coal for 16 days' steaming. She is of steel, the plates being rolled by the West Cumberland Steel and Iron Company. The position of the water ballast tanks will be seen from the drawings, as will that of the cable tanks, of which there are four. The tanks are similarly built, though not all the same size. It will be sufficient to describe one, say No. 2 tank, which is about 25ft. × 12ft., built on top of forward ballast tank. The top of water ballast tank is ½in. The plating is of steel of good quality, sides of tank ⅜in. in one length, plated vertically, with double-riveted external butt strips 9in. × 7/16in., with vertical joints planed, and all riveting perfectly flush inside. This tank is fitted with a cone, flush-plated, tapering from 6ft. to 3ft., with plate top. The bottom angles on top of water ballast tank are 3½in. × 2½in. × ½in. The top angles are double, 3in. × 3in. × 7/16in. inside and outside of tank to receive the feet of pillars from girders under deck to top of tank. The inside angles have eye-bolts about 8ft. apart for life lines, and recessed foot pockets for ascending and descending. The after-tanks, Nos. 3 and 4, have bottoms ½in., sides ⅜in., and strips 7/16in., angles like No. 2.

The main deck is plated with steel fore and aft, according to Lloyd's rules, covered by a 3in. × 6in. teak deck, in long lengths, fastened with galvanised bolts and nuts, and finished in the usual manner.

The fresh water tanks are in the fore hold, and the vessel carries two of Starnes and Sons' cylinder condensers, capable of condensing 5,000 gallons per day. The improved steam stearing gear of Davis and Co. is adopted. The fore and main masts are of steel, with wooden telescopic topmasts. A continuous line of railings is carried round the ship, the entire length of which is also fitted with awning stanchions of galvanised iron 8ft. apart, with galvanised plates on rails and sockets on waterway. The awning has support centrally on pillars of galvanised iron, with ridge lines of galvanised wire and boxes of yellow pine. This is not a luxury, but, with side curtains, a necessity in tropical climes. The ship carries six boats, two lifeboats, two cutters, captain's gig, and a dingy, fitted and hung in the most approved manner.

The ship is lighted partially by electricity, a special engine and dynamos being placed therefor upon a platform in the engine room. Incandescent lamps are fitted in the saloon, saloon cabins, steward's pantry, in the cabins of the officers, electricians, and engineers, in the chart, engine, dynamo, and testing rooms, in the cable tanks and along awning deck, while a powerful search light with reflector is on the bridge. The electric light, as well as the cable apparatus, has been supplied by Messrs. Johnson and Phillips, of Charlton, while all the electrical apparatus (of which more hereafter) is by Messrs. Elliott Brothers, of the Strand. The vessel is being fitted by Messrs. M'Whirter, Roberts and Co., with their system of exhaust ventilation by steam, as fitted to several other telegraph ships, by which means 1,000 cubic feet of air per minute is extracted by each ventilator.

Of course a well-fitted workshop is one of the first necessities on board a cable ship, and that of the "Magneta" will be found very perfect. The testing room is on awning deck in line with the wheel house, and is built of teak, and care has been taken in construction to avoid as much as possible vibration from the steam stearing gear, which would disturb the instruments. A steam winch is fitted on the main deck, and a steam sounding machine, fitted complete with sounding wire and leads by Messrs. Johnson and Phillips, is as near the taffrail as convenient. As we hope to illustrate the engines among other details of the vessel, we shall only now say they are 200 horse-power, of the compound surface condensing type, with inverted cylinders and direct acting. The boilers are of the cylindrical multitubular type, two in number, built entirely of the West Cumberland Steel and Iron Company's brand, with three furnaces to each. The furnaces are Fox's patent corrugated, the parts exposed to fire being of Lowmoor iron, the shell of steel. In addition there is a donkey boiler of the cylindrical multitubular type; tubes, 2½in. in diameter. Both main and donkey boilers are fitted with Galley's patent bars.

From these few details, it will be seen that the most modern improvements in every direction have been utilised in order to make the ship in every shape and form most competent for the work she has to do.

The cable gear is of the most modern design, and consists of bow guards and triple sheaves, davits, crosspiece and three tackles, stopper hooks and plummer blocks, dynamometers for both picking up and paying out over bows, to register very light and very heavy strains, with all lead wheels. Then we have a double combined picking up and paying out machine, with engines of special design, with holding back gear for paying out, and draw off gear for picking up. To insure rigidity and avoid pillars in between decks, fore and aft foundation plates are riveted to steel main deck with web plates, double angles top and bottom, with foundation plate and chocks fitted overhead between deck beams in way of holding down bolts.

The saloon is of wainscot oak, inlaid, French polished, with circular panels, gilded capitals, and edges of overhead mouldins gilded. All doors have handsome finger-plates. The hand-rails are of polished maple, with electro-plated brackets in saloon and corridor. The overhead of saloon is done in flatted white, picked with gold on edges of mouldings. The saloon, captain's, chief electrician's, chief engineer's, and assistant electrician's cabins are connected to steward's cabin by means of electricity. Saloon, pantry, closets, and baths have scuppers, all carefully trapped, leading down bilges into waste tank.

It is necessary to say a few words about our illustrations. It may be thought unfortunate that the midship section could not be given on a somewhat larger scale, as the information it contains is both unique and important; still we think that with a little care the whole of the information can be deciphered. The details in the sheer plan, the lower deck, main deck and shade deck plans are on a somewhat larger scale, and ought to be quite clear. With regard to the picture on page 156, our engraver has done his best from the drawings to give a fair representation of the vessel.

The cable department and the electrical department will be dealt with, more fully, and illustrated, in a future article.

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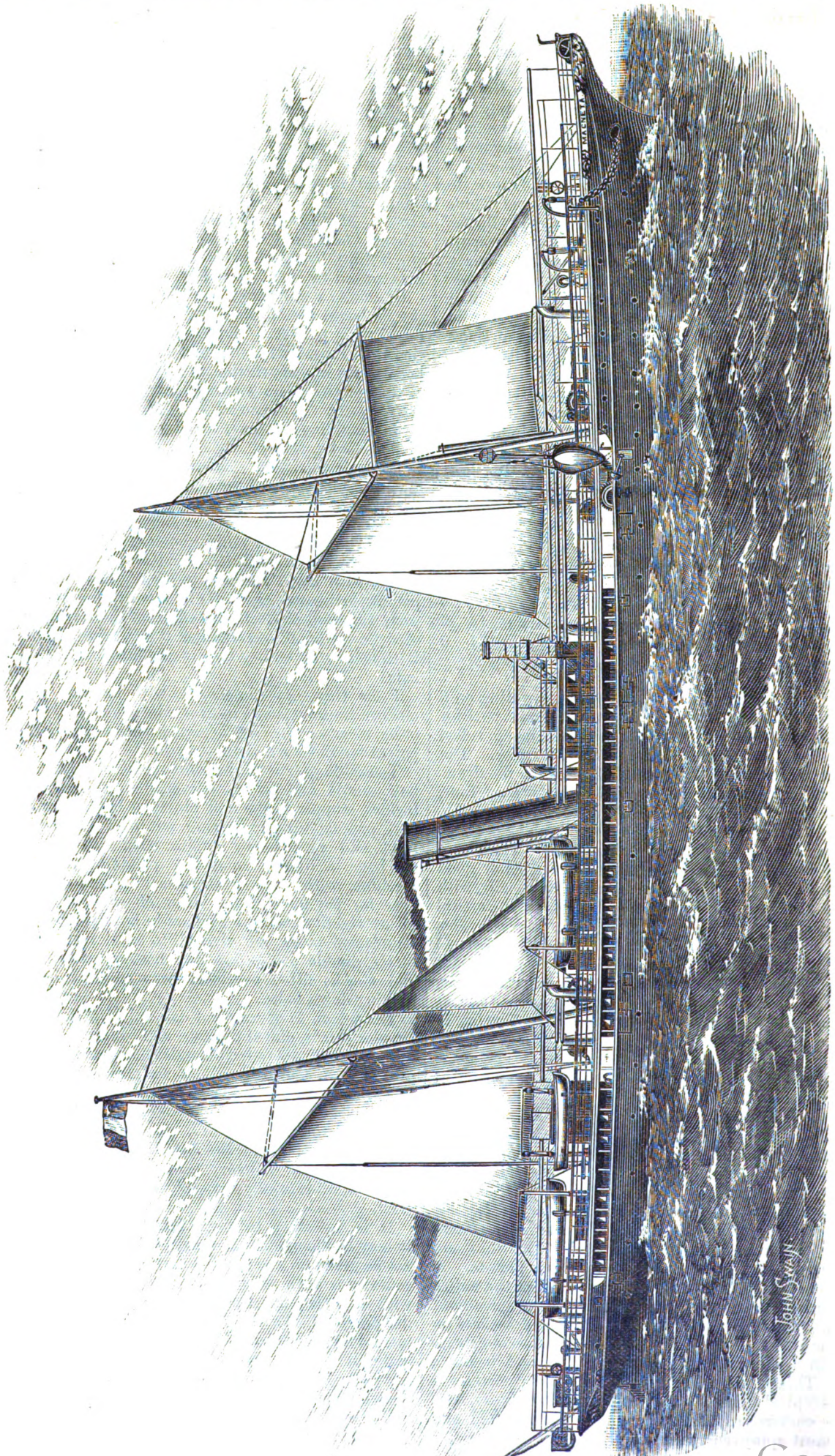

THE ss. MAGNETA.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

SUBSCRIPTIONS.

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	3 months.	6 months.	12 months.
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Cheques and P.O. Orders to be made payable to C. H. W. BIGGS.

Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 *p.m.*

NOTICE.

We this week issue a special Supplement, giving Illustrations showing the details of the ss. "Magneta." Every Subscriber should receive the Supplement Gratis. Should it be wanting, the Manager would be glad to receive notice.

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1884.

Adieu delights, that lulled me asleep;
Adieu my dear, whose love I bought so dear;
Adieu my little lambs and loved sheep;
Adieu ye woods, that oft my witness were;
Adieu good HOBBINOL, that was so true,
Tell ROSALIND, COLIN bids her adieu.

Thus ends the "Shepherd's Calendar." Spenser had sung through every month of the year, and in the words we have quoted bids his adieu. In another fashion we have passed through a year, and now bid it adieu. We speak our farewell with a mixture of sadness and gladness. The sadness is natural. Co-workers are gone from our side, and the coming of a new year reminds us that the time is approaching when the workers of to-day will give place to other workers, and we feel constrained to ask the questions: Are we earnest enough in looking to the security of the foundation upon which our successors are to build? What *esprit de corps* exists among the electricians of England? Is it such as tends to redound to the glory of their country, the advancement of science, and honour to individuals; or is it such as thinks mainly of £ s. d.? Reader, does your answer make you sad or glad; or have you no care in the matter?

The gloom which settled upon the electric lighting industry seems to be passing away, and while activity may not be very pronounced, there exists a widespread feeling that the worst is over. The silver lining of the cloud is widening, and we trust it may soon take the place of the blackness which has so long obscured the outlook. This is a source of gratification. It may not be amiss here to refer to one of the causes—many are just now referring to it as *the* cause—which has proved a scapegoat upon which the vials of wrath have been poured from an indignant and interested body of men. The Electric Lighting Act is now the proverbial red rag, and when mentioned before electrical engineers is sure to arouse their anger. At this juncture, then, we may be pardoned for affirming our consistent attitude as regards the question. We cannot refer to the criticisms of any other technical paper, because such criticisms do not exist. On June 10, 1882, referring to the report of the committee, and more especially to Clauses 8 and 10 of that report, we said "Both are impolitic, for the one will unnecessarily exasperate the gas interests, and the other will not encourage electric enterprise." On July 29th, 1882, on the passing of the Bill we said:—"The compromise entered into as regards the term of years was, like all compromises, not particularly satisfactory to either party; and it must not be assumed because 'all the leading companies with one exception' agreed to it that therefore they approved of it. On this, as on several other points, it was plainly a case of that or nothing." One other quotation from the same volume. On October 28th, 1882, we said:—"What we prefer to see is the electric light promoted by substantial and competent people, who will do a legitimate business in a thoroughly workmanlike manner." With these and many similar utterances, we cannot be taunted with not having considered the question; and when we now say—and say most emphatically—that the Electric Lighting Act has proved a blessing and not a curse, we may perhaps command attention.

At the time the Electric Lighting Act was suggested, the electric lighting enterprise was chiefly in the hands of speculators, promoters, and company mongers. It is in such hands now to a far greater extent than is good for it; but many of these parasites have been strangled off. There are still some left hanging on; but we have to thank the Electric Lighting Act for having swept away the worst of them, and also for having taught us that wisdom is not the growth of a night. Where was the experience in these companies? The answer is simple. Experience there was none. Experience has been gained at the expense of shareholders. We can point to it now; but the wisdom of to-day says ignorance in electric lighting matters was "intense" in those days. And yet it was into these ignorant hands that the future industry was to be given. The Electric Lighting Act was a blessing in disguise, and we are not so sure that we are even yet endowed with the necessary experience and foresight to enable us to draft satisfactory clauses to such an Act. The Act, to be of real service, should have certain clauses repealed and others inserted that will permit the industry with the least inconvenience to "drift" onwards. The electric light is at this moment a luxury. Then let it spread as a luxury; let it become fashionable; let it permeate and take root among those who can afford to pay for it, extending gradually but surely. Some of our electric light engineers could light a house; some could light a ship; but we doubt if there is one that can light a town—that is, light a town with the same certainty that a gas company can—giving a horrible light, nasty, disagreeable, dangerous, but commercially profitable. Putting aside Mr. Crompton, who, perhaps, has no compeer in electric lighting experience, it is to such men as Esson, Howard, Kapp,

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Mordey, Sayers, Sellon, Wright, &c., that we have to look for carrying on the work to greater success. These men, with dozens of their colleagues daily conversant with the practice, have the inestimable advantage of the investigations of Professor Sir W. Thomson, Professor Garnett, Professor Lodge, Professor Thompson, and others, who are laboriously delving into the laws which regulate the practical work. It is marvellous how keenly the practical watches the theoretical, and the theoretical the practical. No sooner is a new experiment devised and certified in the laboratory than it is tried in the workshop; and, on the other hand, the investigation into the why and the wherefore of all practical work is searching and unremittent. The unknown, like the infinite, is as vast as our conception, and the words of Tiberius Cavallo, F.R.S., written more than a hundred years ago, are as applicable as if they were written yesterday. The last paragraph of his introduction to "A Complete Treatise on Electricity," second edition, 1782, reads as follows:—"Since the time of this discovery,* the prodigious number of electricians' experiments and new facts that have been daily produced from every corner of Europe, and other parts of the world, is almost incredible. Discoveries crowded upon discoveries; improvements upon improvements; and the science ever since that time went on with so rapid a course, and is now spreading so amazingly fast, that it seems as if the subject would be soon exhausted, and electricians arrive at an end of their researches. But, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps equally or more important than those already made." We look upon Cavallo's knowledge as dry bones compared with our own. Yet we can imagine a writer of a century hence asking whether the students of 1884 really understood the veriest rudiments of the subject. Cavallo's words should act as an incentive to all who feel interested in the science, should lead to hard work, though the student ought never to forget to go back before looking forward. The making of oneself acquainted with what has been done is the best method of preparing to plunge into the vast labyrinth of work to be done; and, above all, when about to start on the forward path be sure to determine well at what you aim. Desultory experiment is one of the curses of the age. The hope of stumbling accidently upon the philosopher's stone has been, and is, the source of more trials and privations than the breaking of stones upon the Queen's highway.

We have rather wandered away from our subject in giving advice to students, but we now return to consider another cause which operates somewhat against confidence in electric lighting and is a bar to progress. A kind and valued correspondent, whose experience is great, although more Continental than English, has put the case so forcibly, aptly, and clearly that we are fain to use his words. Readers will pardon the departure from elegance of expression, and admit its forcibleness:—"You wish my opinion upon the present and future position of the electric light industry. Well, here it is. We are at present on the eve of a new epoch. Electric light shall always go blooming on, but the question is with what rapidity? What are the obstacles that prevent it from rushing forwards and spreading itself everywhere according to the expectations expressed at its birth a few years ago? One of these obstacles is that within the last few years an innumerable number of 'petite' companies have arisen; they have sprouted up, we really know that they exist, and something more. The mere fact of the existence of such companies has done more to retard the progression of electricity in its applications than to push and elevate it. Now and then a party who wishes an installation of electric light falls into the hands of a drummer who represents such a 'Cheap John' Company, and, with the eloquence of a lightning-rod man, he succeeds in inducing the above said party to try his system (as he calls it). Then they bring their traps. The machine, for instance, is a direct piratical infringement on another man's machine—the only difference from the original is that it is painted red instead of brown—and naturally, of course, is less efficient. Their lamp is also an abortion of the lawful lamp; in fact, everything they have encroaches on other men's ideas. Well, then they install their light—perhaps it is done by a youthful prodigy, who as a boy showed his early ingenuity by taking apart the works of a clock and putting them together again, so that a fond mother thought he would be an Edison No. 2. His father, who owns one half of the shares of the Cheap John Electric Light and Power Company, manages to find a berth for his son as engineer to the company. This inexperienced youth has the audacity to begin to install the so-called plant. He had learned while at school that one wire must be connected to the positive pole, and the other wire to the negative pole of the machine. He also knows that the machine is to be put upon its base. His books tell him that pure water is an insulator, and therefore he takes no precaution against damp and watery places where his wires may run. Then, again, he says, "Ain't they covered with zinc oxide? That won't let any fluids through." He will also talk about the theory of potential to somebody whose path in life has never led him to be entangled with electricity, and will go on to say that in order to 'comprendre' the subject one must be well versed in the higher branches of mathematics. He will have the cheek to ask you if you understand mathematics. When he is introduced to you he will generally burst out, as if it were irresistible, saying, 'When I was at the University of Edinburgh, A l'Ecole Central de Paris, or Das Polytechnik von Wien.' Yes, he takes great pride in the mere fact that he was at one of these learned institutions; but he don't tell you that he spent all his time in rowing and football, in going to the 'Cafés Chantantes,' or at the 'Bierhäuser,' drinking himself sick. These qualities he considered the most important factors of his education, and it made him a first-class society man. His studies were secondary matters; study is tedious, and he did not want to ruin his health, for the captain of the club told him of a man who studied so much that he was overworked and got crazy. Of course he thinks differently now, and when he started his installation there was a gushing of electricity at the wrong spot. The armature of a machine is burned, and is sent to the factory to be repaired or replaced, he himself knowing no more of what is inside of the armature, as it seems to him, than he knows of the man in the moon. He gets another bobbin, and this time his main lines and branches give a greenish light, but the lamps are black. Perhaps he thinks that he has discovered some new law or theory that is unknown to the scientific world. While he is trying to solve this new problem the proprietor of the place rushes in, perspiring, swearing, and calling him impious names—telling him if he don't hurry out with all his traps in just about one day he will pull them down and resign him to the mercies of the big bulldog waiting for human gore just by the gate. This takes some starch out of the young man. But what is the result? The proprietor swears he will never have any other electric light, and also warns his brother manufacturers, giving them the experiences he has just met with. Thus the reputation of an honest and lawful firm is soiled by these Cheap John firms, and also by

* The discovery referred to is that of the Leyden jar.

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inexperienced men. It is ten to one that a party having gone through such experiences will always retain some prejudice against the electric light. One might naturally ask why the inventors do not take proceedings against such concerns? It is simply this, the original inventor does not take any notice of them, as the business they do is so small that such a course would be but a waste of time and money. I dare say some would feel flattered if originality would contest with piracy. We have one consolation, and that is a disease which generally infests such companies, called in legal terms the 'winding-up' disease. We read almost every week of some of these 'petite' concerns being extinguished under its influence. It will be then, and only then, when these shabby and crooked associations will give up the 'spark,' that electric light can pass along unprejudiced, and realise the former expectations."

Our correspondent is not far wrong, though in some parts his statements may be open to misapprehension. He does not intend to argue against small companies, or private firms undertaking work. His crusade is against speculators forming a company, palming off pirated goods as the real thing, and employing incompetent men, men who are pitchforked into positions of responsibility, not because of their capacity, but because of influence. We have not one word to say against the employment of "sisters, cousins, and aunts," except in cases of incapacity.

The following excellent letter embodies not the feeling of the writer only, but a very widespread dissatisfaction, as might be proved by the quoting of letters and opinions. The makers of lamps, too, must be constantly on their guard to see that the manufacture is carefully carried on without degeneration. The letter is as follows:—

"Replying to your inquiry as to our opinion on the present position of the electric light industry, we submit to you the following notes, and trust they will not be deemed by you to take up too much of your valuable space. Electric light installations may be broadly divided into two classes. 1st. Central station lighting, implying undertakings which from their magnitude can only be undertaken by joint-stock companies, and which require certain rights of privilege and rights of way necessitating the control of the Board of Trade. 2nd. Private installations, where the whole outlay is incurred by the user of the light, on the same principle as any other outlay in machinery or premises necessary for the purposes of his trade. The state of central station lighting is in a 'comatose' state, and likely to remain so until the vexatious and prohibitory regulations of the Board of Trade are altered. A committee has been formed with a view to obtain these alterations, and no doubt will do some good. At the same time we are rather surprised to see how little representative this committee is, private manufacturing firms, who have, after all, carried out most of the electric lighting in the country, being hardly represented at all, and the greater part of the committee apparently representing the few remaining electric light companies who have weathered the storms of the last two years. As regards private installations, there is in our opinion no manner of doubt that an enormous extension will take place during the near future in mills, works, ships, &c., having steam or water power to spare, provided certain difficulties can be overcome. The direction in which this increase should take place will be far more in incandescent than in arc lighting, because the latter is suited to only a fraction the number of cases that the former is. The dynamo and arc lamp have arrived at a stage of improvement which leaves not much to gain in the future. It is far otherwise with the incandescent lamp. We know of nothing connected with electric lighting so utterly unsatisfactory as the efficiency and durability of the incandescent lamp. We know of nothing more open to improvement in all the conditions of its manufacture and sale. A purchaser of these lamps is told that they will last with fair usage 1,000 hours. He orders a parcel of lamps to give 20 candle-power, and work at 100 volts. If he asks such a question he is told that they take 45, 60, or 70 watts, according to the maker. He is perhaps a contractor fitting up a mill, and the representations he makes to the mill-owner as to the durability are the echo of the character imputed to the lamps by the makers. Now, we as such contractors have bought some scores of parcels of lamps the last six months under the above representations from different makers, and our almost invariable experience is as follows:—First, that though we buy lamps, for example, to give 20 candle-power at 100 volts, and carefully keep the potential of current much below this even at the terminals of the machine, a considerable proportion of the lamps give out in the first week of running. Second, that when we have taken the trouble to test the lamps before sending them out to see what watt-power they take to bring them up to a given standard of candle-power we invariably find there is a wide variation in the limits of watt-power required. A parcel of lamps, for instance, said to take an average of 65 watts will consist of lamps of every grade of efficiency from 50 to 70. The significance of these facts lies in the consequent deduction that either you must run these lamps so that a large number are little better than what Mr. Trotter calls 'red hot hair pins,' or you must run them so as to involve a risk of a considerable number very quickly bursting. Third, we find no marked advantage in these points in lamps bought from a maker claiming great durability at a cost of an expenditure of $3\frac{1}{2}$ watts per candle-power in the lamps and those supplied by a maker claiming an efficiency of $2\frac{1}{4}$ watts per candle-power. Now, we say advisedly, from our own experience, that *nothing* tends to hinder the progress of incandescent lighting so much as the little dependence to be placed on the durability of these lamps. Coupled with the high price asked for them, an increased durability in the lamps would be a great gain, and a diminution in price a still greater one, because the latter is a tangible advantage demonstrable to everyone, while the former requires a considerable amount of faith and a good many trials before it can be demonstrated as being the character of any new lamp offered. It is evident to anyone at all conversant with the manufacture of incandescent lamps that they can be made for less than 1s., and therefore should be sold for less than 5s. Apart from the efforts of makers to keep the price up, the main justification of the high price of lamps is doubtless the great variety of types asked for—every voltage, from 45 to 100 volts, having to be supplied. If two or three recognised potentials were adopted in the trade as standard lamps—say, 50, $66\frac{2}{3}$, and 100 volts—and these lamps were at a much lower price, leaving lamps taking intermediate potentials at present prices, the demand for and output of those three types would so largely increase that they could soon be sold at as good a profit to the makers as the 5s. price now brings them. But this determination of the best potentials for standard types of lamps should not be left to the makers, but be referred to a committee of those interested in the advance of incandescent lighting; and the same committee might investigate the various conditions under which incandescent lamps are usually worked, to see if there are any points detrimental to their life or otherwise which are not yet sufficiently investigated. In any case it is earnestly to be hoped, in the interest of electric lighting, that there will be no attempt to secure a monopoly of any branch of it to any financial company. A kindred industry has been crushed out in this manner, and the country

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practically deprived of a valuable invention for many years to come, and the outlook for electric lighting would be most dismal were the same history to be enacted in its case. If this does not happen, and if the price and durability of incandescent lamps are (as everyone knows they can be) greatly improved, we need have no fear as to the future of electric lighting."

Another correspondent, writing under totally different circumstances, corroborates the views above put forward with reference to the Electric Lighting Act, but says:—"I do not consider that this deserves all the blame cast upon it. However easy it had been, the bogus companies would not have paid anything to the shareholders, and the removal of the restrictions (if effected) will be used in an attempt to bleed the public still more, and nothing will be done to the good of electric lighting until all the company mongering is done with, and the companies swept away, and the sooner the better. Should the Board of Trade give way and more money be raised, the effect will be that electric lighting will receive another check."

Upon incandescent lamps he writes as follows:—"The principal thing to be desired is greater duration of the filament in the incandescent lamps, combined with great efficiency, and from personal observation I am inclined to think that the life of a very large percentage of lamps is cut off from want of equality in the filament itself; *i.e.*, a certain spot in it seems to offer more resistance, and the greater development of incandescence or heat at that spot seems to nip it asunder, and yet nothing is perceptible to the eye. Another great practical difficulty is the varying E.M.F. required by the filaments. Although nominally all sent out as equal, the variation is so great that in a room containing, say, 200 to 500 lamps the varying brightness is very perceptible to the eye, and the brightest ones soon go. If you buy, say, 1,000 at a time, so as to pick out the lamps, you are defeated, for the larger number you get the less carefully they are selected, and, apart from this, in an installation of 1,200 lamps you would need a stock of about 10,000, and besides the wasted time selecting, what is to be done with all the rejected ones? A large number are also defective at the eyes, so that the first attempt at using them spoils them. I calculate that those trivial matters alone would make or lose a 5 per cent. dividend to shareholders without waiting for a theoretically perfect lamp. With regard to the E.M.F. allowed, it seems necessary that it should be fairly high, for it will never pay to lay down mains sufficient to supply every house in a district large enough to carry current with a low E.M.F.; neither must the E.M.F. be too high, because however perfect cables may be made it is certain that, allowing for the rough handling of workmen, &c., any cable would be very short-lived placed underground. A system of secondary generators also seems to be necessary, because it must be possible to light or turn out single lamps, and up to the present high resistance lamps possess in a higher degree the faults of the low ones, and one or two of their own. An E.M.F. of 400 to 600 volts will be high enough for fair economy in cables, and quite as much as an average cable will stand; a secondary generator having an efficiency of 85 per cent. would pass muster. Secondary batteries in any of their present forms are a failure as regards town lighting. With regard to price, electric lighting will command 50 per cent. more than gas readily. Engines and dynamos, both in price and efficiency, leave little to complain about, the actual cost being small compared with the total capital required. In conclusion I feel that making the best use of our present knowledge will give good results to all concerned, and every advance make things better still."

Mr. Lever writes very fully as to his experience, which, no doubt, is not unique; but, as he puts the matter somewhat differently to either of the other correspondents already quoted, we herewith give his remarks:—"My experience," he says, "of electric lighting in this country is that the public is very slow to move in the matter. Until the Electric Lighting Act be materially altered, we shall never be able to do much with incandescent lighting. Take the Manchester district for instance, where gas is supplied at something like 2s. 6d. per thousand feet, or a little higher than this. The gas is of excellent quality, and gives about 21 candle-power with a burner consuming, say, 4ft. per hour, or, in other words, a 4ft. burner gives a better light than a 20 candle-power Swan lamp. Moreover, the Manchester Corporation light all the streets in the city free, and yet make a clear profit of £500 every working day in the week, or £150,000 every year. Imagine an electric light company competing with this! The greatest field for us to work in lies, in my opinion, in engineering work, foundries, workshops, &c., and here I have always found a great prejudice against incandescent lights. What is required is an artificial daylight—if I may use the term—a light by means of which the men can be watched and better superintended than by gaslight, and by means of which the work can be done more quickly and with greater precision than by gaslight. This the arc light alone can give. It is necessary, first of all, that the inventor, patentee, or whoever else it may be, who is 'pushing' a particular system of arc lighting, have the greatest confidence in that system, and he must be convinced in every way that it is thoroughly practicable. He must, indeed, imagine that there is not a system anywhere to equal that which he has to offer, but, at the same time, he should be careful not to say 'nasty' things about other systems, which, I am sorry to say, some people do. He must, however, be prepared to meet with disappointments and anxieties, which invariably accompany the introduction of new inventions. In the field, then, in which I say there is the greatest scope we meet with three classes of people:—1st, those who are quite content with gas; 2nd, those people who say they cannot afford; 3rd, those who would adopt the electric light, but think the whole thing is in its infancy, and imagine that every day some discovery may 'crop up' which will send all the present inventions into oblivion. The first class are luckily not very numerous; so we may leave them alone until they change their opinions. The second class of people only want the matter bringing well before them, the advantages pointed out to them, and they will soon be convinced that it will pay them. The system should, therefore, be a cheap one. We may say the same in regard to the third class of people, only that the efficiency of the dynamos, lamps, &c., should be pointed out. They should be convinced that any improvements which will be made can only be 'step by step' improvements. The inventor, patentee, &c., who is introducing the system should be willing to put his system in the works on trial if asked to do so. If a man has not sufficient confidence in his system to permit of his doing this, the sooner that man improves his system the better. A reputation must be gained, and it must have a beginning. It is unreasonable to expect any business man to take up a new invention without knowing whether it will suit his purpose or not, and he naturally wants a trial. The system of arc lighting should be simple, easily understood, and not liable to get out of order. It is not sufficent that the inventor, patentee, &c., employs his own men to work the lights whilst they are on trial. The intending purchaser should have the system in his own hands, and employ his own man or men to look after the installation. If after the necessary instructions be given the system will not

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work, it is not a practical system. Perfection of feed in the lamps means complicated mechanism as a rule, and such lamps are unsuitable for workshops, &c., for this reason. The system will most likely be tried from some shafting which is driven by the engine working all the machinery. If a large number of arc lights be required, the fact of a separate engine having to be provided very frequently runs the price up so high that those who would adopt the electric light are debarred from doing so. Hence the system should work with a reasonable variation of speed on the dynamos. So long as a lamp is practically steady, it is all that is required. Everything connected with the system should have a good workable margin; nothing should be 'cut' too fine, and all weak points should be remedied immediately they are discovered. Now I do not think there are more than half a dozen systems in this country which will stand this test, and it is a test I find which will be necessary in order to do any great amount of business. The commercial aspects may not look encouraging, but it is surprising to find how quickly one man follows another in adopting the electric light. An installation successfully carried out in one works brings dozens of people in the same line of business to see it at work. They are told that the light was tried as an experiment; that their own men can easily manage everything in connection with the installation, and this brings business. The arduous task of trying the experiment in some one else's works or foundry is not very often repeated. Other intending purchasers have seen the lights at work, they have seen a successful installation, and they don't like to be 'behind the times.' Business spreads very rapidly in this way, and inquiries come from unsuspected quarters. One thing is evident, viz., that those engaged in electric lighting must not sit still and expect orders to come to them. Some of them have done this long enough, and the sooner they bestir themselves the better will be our prospects."

The ANGLO-BRUSH COMPANY.—With the Anglo-American Brush Electric Light Corporation the past year has been one of considerable activity and progress. The business of the company has been largely extended contemporaneously with marked improvements in their manufactures. Their foundations have been strengthened and prospects improved. Further advance has been made in the development of their incandescent apparatus, the Victoria dynamo both in large and small sizes having been still further perfected, and the development of their incandescent lamp has now culminated in what is known as the Victoria lamp. For this lamp an increased efficiency of about twenty per cent. and a longer life are claimed, while a greater uniformity of light is obtained. In arc apparatus the progress has been equally great. The new Brush armature has been put into the market, whereby the output of any Brush machine has been raised by about forty per cent., while the horse-power absorbed per light is diminished. The new ratchet arc lamp has also proved highly satisfactory in giving a steady light. A complete system of switches, cut-outs, and fittings of every kind has been brought out by the corporation and put into practical work, and has proved the reliability and easy management of incandescent electric lighting when installed in a workmanlike manner at the outset. It is only to be expected from this advance that the corporation have done a large amount of profitable work. Among the many installations completed by the corporation during the year the following may be mentioned :—The Forestry Exhibition at Edinburgh, which was exclusively lighted by the corporation, to the complete satisfaction, we understand, of the committee; Messrs. Courtaulds at Braintree, Essex; Messrs. Gray, Hull; the Driffield Cake Company, &c., while apparatus has been supplied for lighting Buckingham Palace, Grand Hotel, Bank of England, Gaiety Theatre, Plymouth New Pier and Promenade, and the Fine Art Exhibition in Bristol, &c. Shipments have been made to all parts of the world, including Cape Town, Australia, Germany, Moscow, Norway, and Sweden, &c. Among the best records, however, of the work done by the Corporation during the past year are installations of the electric light carried out for the Admiralty on board Her Majesty's ships of war. For the purposes of ship and search lighting the corporation's plant has been largely called into requisition, and is now in use on board the "Colossus," "Ajax," "Bacchante," "Conqueror," "Cleopatra," "Dreadnought," "Dolphin," "Linnet," "Leander," "Reindeer," &c. Electrical installations have also been supplied to Her Majesty's War Department and the Northern Lighthouse Board, and this class of business has been, through the medium of agents, extended to merchant ships and foreign navies. In a *résumé* of the work done during the past year the very prominent part taken by that company in the agitation for a reform in electric lighting legislation deserves notice. The officers of the corporation were, we believe, among the first to draw the attention of the public to the onerous conditions imposed upon electric lighting companies by the Legislature, and it is to Lord Thurlow, the chairman of the corporation, that we owe the organisation which led up to the recent interview with the President of the Board of Trade, and has now assumed the form of a powerful committee, whose object it is to confer with the Board of Trade, and otherwise to prepare the way for the early amendment of the Electric Lighting Act. Thus, though the past year may be looked upon as having been one of great depression in electric lighting circles, it will be seen from this brief summary that the Brush Company have been active not only for the benefit of their shareholders, but also in the interest of the industry generally, and have made real and substantial progress, so that with the improved outlook for the coming year this company may be congratulated upon its position and prospects.

Messrs. CROMPTON and Co.—During the past year this firm has been busily engaged in manufacturing dynamos, arc lamps, and all the various accessories required for incandescent as well as arc lighting, and for the electrical transmission of power. The works in Chelmsford have been greatly enlarged, and the number of men now employed is greater than at any previous period. The introduction of the new Crompton dynamo is the most important feature of the year. This dynamo, as most of our readers will remember, is a development of the Gramme ring type of machine. The armature core consists of a very massive ring made up of thin discs of Swedish charcoal iron fixed on a central steel spindle by short arms of phosphor bronze, which are dovetailed into thin discs. At intervals gaps are left for ventilation. The winding consists of a single thickness only of coils. The field-magnets are very massive and are also of soft wrought iron. These machines give exceedingly high E.M.F. at a slow speed and with low armature resistance; there is hardly any lead at the brushes, and the sparking is *nil*. A considerable number of these machines, varying from 60 to 800 lighters, have been sent out; three of them, designed to run 1,000 lights each, are well on the way towards completion.

Three large machines, each driven direct by a three-cylinder compound Willans engine, have been constructed as exciters for the enormous Gordon machines about to be put down at the Paddington Station of the Great Western Railway. Three large machines of similar construction are being constructed for the Brazilian ironclad the "Aguidalan," the lighting of which

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has been entrusted to this firm. They have constructed six sets of combined engines and dynamos for lighting the trains of the Great Eastern Railway, which will work their suburban traffic on the Epping Forest line. The engines used are the "Tower" engines made by Heenan and Froude, and the whole arrangement is extremely compact, measuring about 3ft. 6in. long by 1ft. 8in. wide by 12in. high. We hear that these little engines and dynamos have given great satisfaction, and this department of train lighting promises to be a prominent feature in the firm's next year's trade. Turning now to arc lamps, Messrs. Crompton have turned out some 600 double lamps of the Crompton-Crabb type, and their use is rapidly extending. Those put up a year ago for the Forth Bridge works have stood extremely rough usage, with entire immunity from breakdowns; and, although the high price of carbons in this country prevents arc lighting from attaining the prosperity and development it has shown in the United States, there is every reason to believe that the uniformly good behaviour of these lamps is contributing in no small degree to a renewal of the demand for arc lighting plant. Messrs. Crompton and Company have been working out with Mr. Willans the development of the electric governors brought out by them and Mr. Wilson Hartnell. The large engines at Victoria Station are now controlled by these governors, and the current supplied to the lamps thus employed has been maintained within a narrower percentage of the standard E.M.F. than has, we believe, ever been the case at any electric lighting station either in this country or America. Other specialities of Messrs. Crompton's manufacture have been the current and potential measuring instruments invented by Messrs. Kapp and Crompton, and described by us. Several hundred of those instruments, all made and calibrated at Chelmsford, are now in daily use in the hands of the public. With the kind assistance of Lord Rayleigh, Messrs. Kapp and Crompton have lately been able to obtain verified readings of correct multiples of the new standard volt at 20, 50, and 100 volts. They have also received from Mr. Weston in America a table of independent tests which prove conclusively not only the accuracy of the original calibration of these instruments, but also that they retain this accuracy even after rough usage and travel. Mr. Weston's tests showed a duration throughout the entire range of the instrument of less than $\frac{1}{4}$ of a volt from his standards. The list of separate installations carried out by this firm by themselves and by their agents is an exceedingly long one. We will only refer to two of them. First, that at Victoria, which has been so recently described by us that we need only call attention to it as undoubtedly the largest and most complete in the United Kingdom; and, second, that at the Palsgrave Restaurant as one which, though belonging to a previous year, is interesting in that it has been tried in the balance with its rival, gas, and has not been found wanting. In the first instance, as the maintenance of the machinery at the Palsgrave Restaurant was found to be very costly, it was thought, erroneously as it has turned out, that by discontinuing the use of part of the electric light and by substituting gas for it, some money saving would be effected. The partisans of gas were highly jubilant, and our contemporaries who write in the gas interest were proportionately triumphant. However, after a fair trial of the gas, it has been conclusively shown that the high cost of maintenance of the complicated machinery in these buildings was not due to the electric light but to other causes, and that the electric light was not more costly than gas. It has therefore been decided to discontinue the gas and go back to the electric light.

THE HAMMOND ELECTRIC LIGHT COMPANY.—This company notices on all hands a more sensible appreciation of the advantages of the electric light, and less of that wavering indecision which has characterised the would-be user hitherto. Satisfaction is felt by those interested in the company that the installations put up two years ago have been running without any more trouble than a little attention now and then to the wearing parts of the apparatus, and this has been specially the case where the apparatus is generally severely tested by dust and smoke. Among the installations carried out are the following:—Messrs. J. Readhead and Sons, South Shields, one 16 arc light apparatus; St. Peter's College, Cambridge, complete plant for 150 lights, the generator being a Ferranti machine; Messrs. J. and J. Colman, Norwich, 1,000 lights run from a 1,000 light Ferranti machine, similar to that exhibited at the Health Exhibition; William Whiteley, Esq., Westbourne-grove, W., a 1,000 light machine; Central Marine Engineering Works, 16 arc light plant, erected only; Stanner's Closes Steel Works, Walsingham, an extension of arc lighting; Civil Service Stores, Queen Victoria-street, incandescent lighting of board room and offices; Messrs. Denny and Brothers, Dumbarton, incandescent lighting for two steamships; James Laing, Esq., Sunderland, incandescent lighting for one steamship; T. C. Eltringham, Esq., South Shields, arc installation, &c. They have during the year produced, in the latest type of Ferranti machine as exhibited at the Health Exhibition and awarded a gold medal, a machine which bids fair to hold its own in the struggle for existence. A new direct acting engine has been designed, and has been working satisfactorily at the works in Appold-street, which is said to embody many improvements. We shall doubtless shortly hear more of this engine.

LATIMER CLARK, MUIRHEAD, AND CO.—During the year this old established firm has been formed into a private company, Mr. A. Le Neve Foster, late of the Silvertown Company, joining as works manager. The work of the company is largely composed of general telegraph and manufacturing work. The work of the greatest public interest during the year that has been done is the manufacture of the apparatus for duplexing with Muirhead's patent system the new Mackay-Bennett Atlantic cables of the Commercial Cable Company. The apparatus before being shipped was exhibited at the *conversazione* of the Royal Society, and also at the *conversazione* of the Society of Telegraph Engineers, at King's College; and it is the first time that so large an exhibition of apparatus and of such value has been brought before the notice of these societies. The company have added to their specialities a new and complete system of submarine mining defence, under the patents of Mr. Latimer Clark and Mr. J. P. Gibbins. The company now manufacture the ammeter, voltmeter, &c., under the patents of Professors Ayrton and Perry; also ships' telegraph and speed indicator, of Messrs. Farquharson and Lane; Mr. Mance's cable testing method, &c. This company has the agency and manufacture in England for the arc lamps of Captain Cardew, R.E., and M. Werner, of Cologne, which are very efficient working lamps. They have lighted up the new premises in Fleet-street of Sir J. Whittaker Ellis, Bart., M.P., with incandescent lamps, using a Victoria dynamo.

J. H. GREENHILL has been one of the most active agents in the development of electric lighting in Ireland. We note with a considerable amount of pleasure that he has extended the light installations in various places during the past year, as well as put up new installations. It is a good sign that people are satisfied when they extend the lighting. Thus Messrs. Harland and Wolff, the well-known shipbuilders, have extended their lighting, and now have in use 250 incandescent lamps and 43 Crompton arc lamps. In addition this firm has 1 Brush dynamo, 18 Brush lamps, 3 Brockie lamps, and 1

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Belfast Electrical Appliance Company's lamp; also 1 Siemens exciter and distributor incandescent machine for 100 lamps. W. J. Shaw and Sons, Limerick, have also extended the light, and have now in operation 3 machines and 310 lamps. J. and T. M. Greeves, of Belfast, have 2 machines and 250 lamps. Among other new installations during the year we may name St. Patrick's Industrial Schools, Belfast, 1 machine 60 lamps, and Messrs. Matterson and Sons, Limerick, 1 machine 130 lamps. This firm has also a large Maxim light installation. Mr. Greenhill, speaking of his experience in lighting his own house with ten incandescent lamps, says:—"It may be considered that it was not worth while introducing the electric light for so small an installation, but this is entirely an erroneous impression, as although I have only one of Crossley's new half horse-power gas engines for the dynamo, yet we can get from 8 to 9 lights of 20 candle-power each quite easily. I have a set of 24 Planté cells, but seldom use them, as I find the lights are perfectly steady without them. The engine and dynamo give no trouble whatever, except the act of starting and stopping; the latter can be done in my house without going out to the little engine house where the machinery is. This installation has been running constantly since Sept. 12, the only hitch during that period being on an occasion when the lights went out for a few minutes by reason of the lacing of the belt giving way, and this could have been avoided by an examination of the belt before starting. If it was only more generally known how pleasant the electric light is, and conducive to health and the preservation of furniture, plants, &c., and how it lends itself to the decoration of the house, it would be far more used by those having the facility for driving the dynamo either by water power, gas, hot-air engines, or steam. I think there is a good opening for a thoroughly efficient hot-air engine for driving the dynamos in country mansions where gas is not to be had, and water power not available."

Mr. C. Lever.—During the year the electric light has been put into part of Mr. Lever's house at Bowdon. The billiard room is lighted by 45 Swan lamps of 20 candle-power each, whilst 18 Swan lamps of the same candle-power, and one Lever arc lamp of 2,000 nominal candle-power, light the offices. The power is obtained from a Marshall's vertical engine and boiler, and two Bürgin machines—one of which is always kept in reserve—generate the requisite current. This system of lighting has been adopted in the spinning of coloured goods by Messrs. W. Blackburn and Co., Clarence Mill, Cleckheaton. Six Lever arc lights of 2,000 nominal candle-power each are used for lighting the combing and hanking rooms. A specially designed compound-wound Gramme machine is used for generating the current, and is driven from the shafting which works the machinery in the combing room. These lights were put in last summer, and although the plant has been left entirely in the hands of the firm's workmen, there has not been a single hitch so far, the lights being run morning and night. Messrs. Richards and Co., of the Atlantic Works, Broadheath, have adopted this system, and are now extending the lighting by means of smaller arc lamps of 1,000 nominal candle-power in lieu of Swan's incandescent lamps, which are used in the offices. The dining room is lighted by 20 Swan incandescent lamps of 20 c.-p. each, and about 15 Swan lamps of 20 c.-p. are used for the small lathes and for lighting small corridors, &c. Nine of the small arc lights are being put in for lighting the offices and gallery where the larger arc lamps are unsuitable, so that this firm has the whole of the works lighted with thirty arc lamps and about thirty-five Swan lamps. Five special Gramme machines are used for the arc lighting and a small Phœnix machine for the incandescent lights. Mr. Lever, like many other manufacturers, has spent a good deal of time in perfecting an alternating current dynamo machine. Although the results obtained were very feeble at first, with some important improvements in the details the machine now gives infinitely better results. This machine has been designed more especially for working arc lights in series and incandescent lights in multiple at the same time. A plate of wrought iron is the only revolving part in the machine, and this being of one polarity the coils are connected in a different manner to other alternating current dynamos. There are no collectors or brushes on the machine, consequently it can be left in almost anyone's hands to work.

Messrs. Paterson and Cooper, as will be seen, have carried out a number of installations at home and abroad, either directly or indirectly through their agents, and, like some of the other manufacturers, have supplied apparatus to order for work not carried out under their supervision. The dynamo supplied by this firm is named the "Phœnix." Among other installations the following may be mentioned:—Municipal Buildings and Public Library, Leeds; Government Hospital, Christiania; Craig y nos Castle, Swansea Valley; cloth mills of Mr. Isaac Northrop, Embsay; cloth mills of M. Sheard and Co., Batley. Installations for cloth mills of Messrs. Kessler and Co., Bradford; Messrs. J. Bannister and Sons, Bradford; Messrs. J. Gaunt and Co., Farsley; Messrs. Wilsons and Glenny, Hawick. Installations for Messrs. Mechan and Sons, Glasgow; Messrs. Thomas Adams and Co. (Limited), Nottingham; the cloth mill of Mr. J. Blackburn, Johannsberg, Berlin. They lighted the "Tilly" steamship, built by Hanna, Donald, and Wilson, Glasgow; Rusclokbahkens Bazaar, Christiania; Hœgholmen's shipyard, Christiania; Devolo's wool mills, Aalesund; Gyethus paper mills, Drammen; Nilsen and Matthieson's saw mills, Fredrichstad; J. Shibley and Co.'s cloth mills, Batley; J. L. Stewart and Co., Valley Mills, Bradford. Also for J. Mitchell, Snargate-street, Dover; Phillips Bros., The Combination, Holborn; MacNaughten, Love, and Co., Finsbury; J. Smith, optician, York; Blundell, Spence, and Co., Hull, and J. Henry and Co., Bradford.

The German Edison Company.—This company has not hitherto found a place in our annual *résumé*; but it will be seen that it has done a large amount of work. The light has been installed in 128 establishments, which altogether take some 22,000 Edison lamps, the current being supplied from 169 dynamos, driven by engines of collectively 2,500 horse-power. The following are a few of the larger installations:—The Central Station at Strassburgh with 1,960 lamps, five 250-lamp dynamos, one 450-lamp, one 200-lamp, and one 60-lamp dynamos. The piano factory of Emil Ascherberg, of Dresden, is lighted by 250 lamps, one 250-lamp dynamo giving the required current. The Rositzer Sugar Refinery is lighted with 500 lamps, with two dynamos. The King's Theatre at Stuttgart has 1,060 lamps, fed by four 250-lamp dynamos, and one 60-light dynamo. The factory of Hartmann and Sons, of Münster, has 1,000 lamps, supplied by two 450-light dynamos, and one 100-lighter. Messrs. Burensson and Oldroyd in their factory at Sagan have 500 lamps. The Berlin Central Station is supplying current with four 450-light machines for 1,800 lamps. The theatre at Munich has 2,500 lamps, and so on. Besides the installations of incandescent lamps, a number of installations of arc lamps have been carried out. The installations have been for clubs, hotels, cafés, factories, shops, theatres, town halls, and private residences.

The Liverpool Electric Supply Company.—A number of installations have been carried out under the superintendence of Messrs. Holmes and Vaudrey, the managing directors. Among others, the Adelphi Hotel, Liverpool, 200 incandescent

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lamps; the American Exchange, Liverpool, 24 lamps; the White Star Steamship Company's new works, 400 lamps; Messrs. A. Handyside and Company, Derby, 6 arc lamps; Royal Court Theatre, Liverpool, 6 lamps; Prince of Wales's Theatre, Liverpool, 4 arc and 24 incandescent lamps; Messrs. Hyam, Liverpool, 10 arc lamps; Messrs. Henochsberg and Ellis, Liverpool, 6 lamps; Star Music Hall, Liverpool, 4 lamps; Messrs. Joseph Owen and Sons, 5 lamps; Messrs. H. and C. Grayson, 8 lamps; the India and China Tea Company, Liverpool, 35 incandescent lamps; Messrs. David Rollo and Sons, 5 arc lamps; Thomas H. Edwards, Esq., 20 incandescent lamps. The company is now supplying under rental agreements, from its central station in Rose-street, more than 300 incandescent and 30 arc lights. They have also contracted with the Corporation of Liverpool to supply the electric light to the Free Library and Picton Reading room. The company are also lighting the large ball room and reception rooms of the Wellington Club, Liverpool, 200 incandescent lamps being employed in this installation.

W. T. Henley's Telegraph Works Company early in the year put down new machinery for covering wires with gutta percha, which has been constantly at work since its erection, manufacturing telegraph, torpedo and telephone cable cores, leading-in wires, &c. The company have made several lengths of submarine telegraph cable during the year for various telegraph companies, foreign governments, &c., amongst which we may mention the much-needed cable laid early in the year from the coast of Devonshire to Lundy Island. This cable is one of the strongest, perhaps the strongest, laid off the British coast. It has two sheathings, the first composed of 18 galvanised steel wires, and the second of 15 galvanised B.B. iron wires. The insulation consists of the company's patent ozokerited india rubber. A large quantity of armoured torpedo cable has also been manufactured. It may be mentioned that very satisfactory reports have been given concerning the ozokerited india rubber core put in cables immersed during 1883. A considerable quantity of telephone and electric light cables has been made. The cables purchased by the Commissioners of the International Health Exhibition were made by this company. They were insulated with the ozokerited india rubber, and have given great satisfaction, not a single breakdown having occurred during the exhibition. During the last three or four months of the year the demand for electric light cables, according to this company's experience, has been steadily improving, and leads to the inference that the employment of the electric light is increasing. The demand has been considerably in excess of that for the same period in 1883. The demand for porcelain insulators, galvanised and braided wires, &c., for overhead telegraph and telephone lines, and also in cotton covered, silk covered, and paraffined wires has been fairly good during the year.

The Consolidated Telephone Construction and Maintenance Company.—This company, which was started in 1881 with such bright prospects, seemed under the management of the late Board to have a blight over it, and the report of 1883-4 was one of a most discouraging character; indeed, it looked as if the company was on the verge of liquidation. In May last the shareholders, thoroughly dissatisfied, demanded a Committee of Investigation, and the report of this committee, issued in July, showed such a state of affairs that the shareholders insisted on the resignation of Colonel Gouraud (acting chairman), Hon. H. Spensley, and Mr. P. Carnegy, C.T.E., from their seats at the Board. With fresh blood infused into the Board, the company seems to have taken a new lease of life. The gentlemen who are now in power have for the last six months been actively engaged in putting in order the various undertakings which the company has in hand, and judging from the chairman's speech at the meeting held at the Cannon-street Hotel on the 16th December (which was fully reported in our columns), there seems a good prospect of a sound and lucrative business being carried on under their able and energetic management. The company, besides its ordinary manufacturing business, is largely interested in the River Plate Telephone Company, the Telephone Company of Austria, which company has a ten years' absolute concession to erect exchanges in nine large towns in Austria, and the Edison-Gower-Bell Telephone Company of Europe, who have a twenty years' concession to erect exchanges in Oporto, Lisbon, and elsewhere in Portugal. All the exchanges are doing well and gradually (as seems to be a certainty in the telephone business) working into dividend-paying properties. With the great extension of radius lately granted by the Postmaster-General to the United Telephone Company and its subsidiary companies, the demand for the telephone will assuredly increase greatly, and this increase will favourably affect the Consolidated Company, as under its agreement with the United Telephone Company it has exclusive right to manufacture telephones for the United Kingdom and their affiliated companies under the Bell, Edison, Blake, and Gower-Bell patents. With a steady increase in the manufacturing business and the various exchanges making returns to the parent company, it would seem that the shareholders of this undertaking are now within a measurable distance of a dividend.

Telephony in the South-East.—The Brighton and Hove Exchanges have nearly doubled the number of subscribers. Direct wires have been run between London and Brighton. These are nearly free from inductive effects, and the articulation all that can be desired. The wires are run along the main line of the South-Eastern Railway cross fashion. Business has also been commenced at Eastbourne and Hastings, and exchanges will be opened early in 1885; in fact, several private wires are already at work. It will be necessary, for the due development of telephony, that a much better class of trained engineers be employed, as the constant train of delays and complaints must militate against the enormous development which should await it, and it is much to be feared that the public will have to wait until the present monopoly is abolished; and as Nature's law seems progress, it is useless to suppose that everything is known at present.

Magnus Volk has greatly extended the small electric railway, with the result that there has been an enormous development of traffic, and it may claim to have carried a greater number of passengers than any other electrical undertaking. In electric lighting he has carried out the lighting of the Corn Exchange, Dome Assembly Rooms, Free Library, Picture Gallery, and the lawns. This work has been carried out for the corporation, the extensive lights of the lawn being (as far as known) the first use of incandescent lighting for the purpose. The total number of lamps used in this one installation is about 1,300. Siemens' 500 light new compound machines are used; these show a marked advance in the economy of power. The use of the Maxim 30 candle-power for the Picture Gallery, when driven rather beyond their normal candle-power, has met with great success, the light being all that could be desired, and free from the flicker of the arc.

Although we have incidentally mentioned telephony, telegraphy, submarine telegraphy, transmission of power, &c., this week, we are compelled to leave over the main features of the year's work in these directions to another article.

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PAYING FOR SPECIFCATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think that electrical engineers owe you a deep debt of gratitude for the fearless manner in which you have upheld the true interests of the whole profession in this matter.

No one supposes for a moment that Messrs. Mackenzie and Brougham were actuated by any other motives than those of duty to their client in adopting the course they did, and we now know that they were acting strictly in accordance with his express instructions. In fact, as Sir Coutts Lindsay has practically acknowledged, it is he who is to blame, and not the firm that he employed. It is of course open to question whether Messrs. Mackenzie and Brougham acted with due consideration in accepting such instructions.

It is certainly a somewhat new doctrine that a part of the duty of a consulting engineer is to endeavour to squeeze as much as possible out of competing contractors for a particular piece of work, towards lightening his own professional charges to his own client. I think it is by no means difficult to imagine cases in which such a system might be made the means of something very closely approaching a transaction that most men would call by an ugly name.

Suppose that A starts as a consulting engineer, and makes use of the names of B, C, D, and as many more of his friends as he chooses, to draw specifications for work that B, C, and D have not the slightest intention of having executed, and makes the competing contractors each pay a sum sufficient in the aggregate to reward him very handsomely for his trouble. B, C, and D are under no legal obligation to give the work to any contractor, nor, so far as I understand, was Sir Coutts Lindsay.

I trust I may not be misunderstood in the above. I am not for an instant reflecting on the *bonâ fides* of either Sir Coutts Lindsay or Messrs. Mackenzie and Brougham. I am merely putting the extreme case, what might happen in that delightful village called London, where it is believed men of the character of A, B, and C do occasionally harbour. Leaving, however, the question of *bonâ fides* out altogether, suppose that no rogue ever set up as a consulting engineer, and that it would be impossible for him to do as I have suggested. Come back strictly to moral grounds. Is it right that competing contractors should be made to pay for the professional services of the engineer who draws the specification upon which they are to base their estimates, but from which only one can benefit? There is a suggestion in a contemporary, that these specifications contain valuable technical information which, it being important for contractors to be possessed of, it is therefore just that they should pay towards its preparation.

I think that this argument will hardly hold water. It may occasionally happen that a consulting engineer has a wrinkle not in the possession of contractors; but I believe every one will agree with me, that a consulting engineer who inserted in a specification an untried idea of his own would hardly be doing his duty to his client. Knowledge that is required for drawing specifications is gained by experience of the actual working of apparatus, and I believe I am hardly overdrawing when I say that those who make, or enable others to make, experience of the actual working of different kinds of apparatus, are the very contractors who are to compete for the work when the specification is drawn. It can hardly be just, therefore to make them pay for knowledge or experience which they themselves or some of them have furnished.

We come back therefore to our original point. Given the fact, which no one will dispute, that professional work must be paid for where employed, then who should pay for it?

To answer this, let us ask another question. Whom does the work benefit? For it is clear that he or they who benefit by the labour of others are the proper parties to pay for that labour.

The work in this case benefits Sir Coutts Lindsay's clients, and therefore it is they who should pay Messrs. Mackenzie and Brougham for their services. It is they who will suffer if the light flickers or goes out at inconvenient times, and it is they who will benefit if the light is good. Therefore it is clear that they should pay.

Moreover, it is perfectly clear that they will have to pay whatever Sir Coutts Lindsay has to pay in one form or another; and therefore it would be a manifest injustice to make others pay a part where they receive the whole benefit.

Mr. Crompton has rightly pointed out that, however long the public may take in adopting the electric light, and to whatever expense they may put manufacturers and others, it is they, that same consuming public, and they alone, who in the end will have to pay the bill; and I think there can hardly be a clearer or a more direct case than the one under notice. Either by increased attendance, or by increased charges, Sir Coutts Lindsay's consuming public—the ladies and gentlemen who patronise the Grosvenor Gallery—will have to recoup him for the expenditure which he is now making for their comfort. This being so, as the amount which Sir Coutts Lindsay will receive from his clients in repayment of his present outlay will be independent of how much or how little he pays for professional assistance, and we may therefore assume that the receipts will exceed the expenditure, is it just on the part of any consumer to endeavour, after putting a certain body of men, who have no interest whatever in his venture, to a certain expense in preparing estimates for his benefit, to draw from them (the contractors) a further sum in addition to that he receives from his clients, for which sum he gives no return whatever?

A consumer, having determined to use a certain commodity, has always two courses open to him, supposing that he has not sufficient practical acquaintance with the commodity to risk being his own buyer. He may confide in a firm of suppliers on whom he can rely; or he may endeavour to obtain the benefit of competition between suppliers, and thus obtain his article at a cheaper rate. If he adopts the latter course, however, in the case of very many commodities, always supposing the consumer to have little practical experience himself, he must, to protect himself from unscrupulous suppliers, employ the assistance of some one who is skilled in the particular subject the consumer has in hand, and who has the practical experience which he lacks.

In many cases, notably in the present, in order that suppliers may compete on equal terms, and that there may be no room for dispute when the work is done, detailed specifications have to be prepared. Are these specifications prepared for the benefit of the consumer or the supplier? Clearly the former. Moreover, in the majority of cases, the labour involved is the same whether one supplier tenders or a hundred, the ninety-nine being merely copies, involving only clerical or printer's work.

Suppose that only one supplier tendered. To carry the matter to its logical conclusion, the unfortunate man ought to be charged with the whole cost of preparing the specification. Would this be just? In this case it would, as the supplier would simply add to his estimate the cost of preparing the specification, plus his profit on that as a business transaction. If custom arranged that the successful contractor paid the professional charges, it would also be just, as the consumer would really pay it, but in another form, and possibly with a little interest.

I think, however, a consumer would hardly be prepared to sanction an arrangement by which the man was paid not by the man in whose interest he was paid to watch, but by the man he watched. To make the body of competing suppliers, whatever be the commodity, pay the cost of skilled advice and overlooking between them, while only one can benefit, *must* be unjust.

There only remains to consider the grounds upon which Sir Coutts Lindsay based his instructions to make the competing contractors pay a part, viz., to lessen his own expense, which has been already dealt with, and to see that *bonâ fide* contractors applied for specifications.

It is somewhat difficult to see that Sir C. Lindsay could be injured to any great extent if any reasonable number of firms applied for a specification and did not afterwards tender. Suppose the case of a firm who would tender if the conditions were such as they could accept. How are they to know what the conditions are? So that by refusing copies of the specification, which, once made, can be reproduced at small cost, thereby saving possibly a trifle on the professional bill, he

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may have deprived himself of the services (for that is what it amounts to) of a valuable competitor.

There is, however, as Mr. Crompton points out, a simple and efficacious remedy, ensuring thoroughly that Tom, Dick, and Harry shall not obtain possession of one of the precious documents unless they really intend to make a proper use of it, and that is to charge a fee, returnable on receipt of a *bonâ fide* tender. No firm of standing would object to that arrangement, which, as anyone who will peruse the front columns of the *Engineer* can see for himself, is almost universally adopted by corporations, railway companies, and others.—Yours, &c.,

SIDNEY F. WALKER, M.S.T.E. and E., M.I.M.E.

195, Severn-road, Cardiff, December 24, 1884.

EVOLUTION OF THE ELECTRIC RAILWAY: Its Commercial and Scientific Aspect.*

BY DR. W. ADAMS, MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

Since Denys Papin, in 1687, proposed the transmission of power over long distances pneumatically, human genius in every age and clime has been struggling to solve the problem of power transmission in accordance with the principles of economy.

It is primarily the more desirable to effect this, that advantage may be taken of the various forces of nature, such as the ebb and flow of the tide, swift-running streams and waterfalls, for the performance of work at points located awkwardly or at some distance from the source of power.

Furthermore, since the advent of the steam engine, the economy attending the centralisation of power and its distribution to isolated consumers, even when thus artificially developed, has been fully recognised by all engineers. Various methods have been proposed, for accomplishing this; such, for instance, as pneumatic, hydraulic, cable, and steam transmission. But all have thus far failed to practically meet the requirements, until now electricity has entered the field as a contestant, and seemingly put an end to competition; since it has been both *theoretically* and *practically* demonstrated beyond question by a host of noted scientists, some of whom have the honour of being recognised as among the greatest living engineers—such for instance, as Sir William Armstrong, Sir Frederick Bramwell, Dr. Werner Siemens, Sir William Thomson, Professor John Perry, Professors Preece and Ayrton, M. Marcel Deprez, Count du Moncel, and many others of like scientific celebrity—that electricity may be used as a medium of power transmission with greater facility and economy, all things considered, than any of the other known methods.

It is the invention of the dynamo-electric machine that has rendered possible this method of power transmission. Such a machine yields electricity as the result of rotation imparted to it by the expenditure of mechanical power derived from some natural or artificial source. A portion of this power may be reclaimed by causing the electric current generated in one dynamo machine to circulate through a second similar machine. Hence, all dynamo-electric machines—the name signifying from mechanical motion to electricity—become electro-dynamic machines when the condition of affairs is reversed, and an already existing current of electricity is caused to circulate through them. The second or reclaiming machine, or translating device, as some call it, will, when a "series wound" machine, rotate in an opposite direction and deliver up a certain proportion of the mechanical power expended upon the pulley of the first. This constitutes the basis of the electrical transmission of power. These facts are generally admitted to have been first pointed out and demonstrated by Messrs. Fontaine and Gramme, at the Vienna Exhibition of 1873, although Pacinotti had, in 1861, constructed a motor identical in principle with the modern dynamo-electric machine, and clearly pointed out its reversibility. Considering this question of electric transmission of power from its two principal standpoints—first, as regards the electric current developed from the mechanical power (the steam engine, for instance); and, second, as regards the amount of mechanical power reclaimed from this current at the distant point through the instrumentality of an electro-dynamic motor, the efficiency of the system is 70 per cent., allowing 7 per cent. for loss by leakage in and resistance of the connecting conductor. The amount of energy lost by the two conversions from mechanical motion into electrical energy, and from electrical energy back again into mechanical motion, is a fixed quantity, and practice has demonstrated this to be 13 per cent. from the first, and 10 per cent. from the second process, when the most efficient types of electric generator and electric motor are used.†

The other element of loss—that by leakage in and resistance of the connecting conductor—will naturally vary with the conditions in each individual case, and will depend entirely upon the size and insulation of the connecting conductor. In general it will, in my opinion, be best to base a calculation upon a 7 per cent. loss in the conductor, allowing 5 per cent. for resistance and 2 per cent. for leakage. This, however, will be governed entirely by the peculiar conditions attendant upon each individual case. The rule given by Sir William Thomson is to the effect that the most economical diameter is secured when the two losses (that is, the loss from heating and the interest upon the price of the conductor) are equal. Knowing the cost of one horse-power of electrical energy in any particular locality, which depends upon the price of coal and the efficiency of the machinery used, and the cost of copper per ton, and remembering the formula $H = \frac{C^2 R}{746}$, the calculation for that locality may be readily made. Assuming, however, the loss in the conductor to be 7 per cent., and the loss in each of the translating devices to 10 and 13 per per cent. respectively, the total loss by transmission becomes 30 per cent.; or, in other words, 70 per cent. of the power expended at the point from which the distribution is to take place may be recovered in the reclaiming machines or electric motors. That is to say, we may deliver within reasonable distances just 7-10ths of the power expended in the first instance. For example: a steam engine of 500 horse-power operated at a central station in the centre of a ten-mile circuit could, by the aid of an electric current traversing a suitable conductor, lay down 7-10ths of its power, or 350 horse-power, distributed among as many different points within that circuit. The fact must here be borne in mind that, aside from all considerations of nuisance and cost of services of engineers, this 500 horse-power may be generated in a single engine for one-fourth the cost, in the way of fuel alone, of generating the power in small engines. Consequently, while we lose 30 per cent. of the power by this two-fold conversion and transmission, we more than make up for such loss by this one item—the gain in point of economy of fuel from the saving effected by the generation of our power in one or two large engines as compared with the cost of developing the same power in a number of small engines. Other than this, however, there are very many more important sources of economy and advantages attendant upon the centralisation of our forces. Such an amount of reclaimed power is far in advance of that obtained under similar conditions with compressed air, pulleys and shafting, cables and steam, and approaches the theoretical efficiency of hydraulic transmission as advocated by Sir William Thomson, with the fact in favour of electricity that it possesses the unparalleled advantage of being almost entirely untramelled with the obstacles presented by distance, while it is at the same time remarkably portable and capable of having its direction and intensity changed at the will of a child. No force can be detected in the connecting portions, that is, in the conductor, such as appears during mechanical transmission with shafting and cables or in pipes with compressed air, steam, or water. The conductor is clean, cold, and does not move, appears inert, and can be shifted, bent or moved in any manner with the greatest facility while transmitting many horse-power. The primary source of power and the point of reclamation may be relatively situated most awkwardly, for the electric conductor, which is simply a copper wire, may be brought round the sharpest corner or carried through the most elegantly appointed private room conveniently and without any manner of annoyance or danger. A conductor carrying many horse-power through a room may be rendered imperceptible. There is no noise, no smell, no dirt, no heat, nothing to burst or give way; and the same circuit which may be tapped to provide many horse-power can be as conveniently drawn from to work a sewing or a washing machine, a small ventilator, a table or desk fan, a domestic flour sifter, an egg-beater, a dentist's drill, a jeweller's or dentist's lathe. So convenient a source of light power will give rise to the invention of many new devices for the mechanical performance of much of the light domestic work which now proves a bugbear in every household.

In mining and excavating operations electric transmission will prove of great value, since it involves no danger and may be carried to points inaccessible to any other form of power. For ploughing by power, trials made in France show that electricity can replace steam with advantage and economy.

In Scotland power obtained from a waterfall has been electrically transmitted one mile and a half with an electrical return of 85 per cent. In Prussia, France, Austria, Ireland, and England, many miles of electric railway in successful *commercial* operation demonstrates the feasibility of, and the many advantages attendant upon electric transmission; for, as we shall see further on, this very principle of electric transmission of power to a distance constitutes the foundation of the modern electric railway, and it is here that this principle finds its pre-eminently important application.

* Paper read before the Society of Civil Engineers, America.

† The lecturer here demonstrated the electrical transmission of power by means of two dynamo machines of about 1½ horse-power each; and also by means of two Holtz machines—one acting as generator, the other as a motor. The electric motor used upon this occasion had been continuously and successfully running the machine-shop connected with Dr. Adams' laboratory for over a year.

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TABLE I.

Cost of 1 horse-power hour in shillings if transmitted by electricity (potential 1,500 volts).

H.P. transmitted.	Distance in metres.						Prime Mover.
	100	500	1,000	5,000	10,000	20,000	
5	0·188	0·194	0·201	0·239	0·274	0·433	Steam.
10	0·167	0·173	0·178	0·211	0·258	0·403	
50	0·156	0·161	0·166	0·190	0·227	0·353	
100	0·149	0·154	0·159	0·182	0·219	0·340	
5	0·029	0·030	0·031	0·037	0·043	0·070	Water.
10	0·022	0·023	0·024	0·030	0·039	0·059	
50	0·019	0·020	0·022	0·024	0·026	0·046	
100	0·017	0·018	0·019	0·022	0·024	0·042	

TABLE II.

Cost of 1 horse-power hour in shillings, with hydraulic transmission.

H.P. transmitted.	Distance in metres.						Prime mover.
	100	500	1,000	5,000	10,000	20,000	
5	0·209	0·236	0·263	0·544	0·873	1·653	Steam.
10	0·198	0·213	0·232	0·423	0·641	1·196	
50	0·136	0·142	0·150	0·242	0·351	0·651	
100	0·135	0·141	0·148	0·239	0·345	0·570	
5	0·024	0·032	0·040	0·115	0·208	0·329	Water.
10	0·021	0·025	0·031	0·079	0·138	0·264	
50	0·013	0·015	0·018	0·038	0·063	0·119	
100	0·013	0·014	0·016	0·036	0·060	0·095	

TABLE III.

Cost of 1 horse-power hour in shillings with pneumatic transmission.

H.P. transmitted.	Distance in metres.						Prime mover.
	100	500	1,000	5,000	10,000	20,000	
5	0·225	0·247	0·275	0·483	0·794	1·396	Steam.
10	0·212	0·224	0·239	0·373	0·521	0·863	
50	0·168	0·176	0·182	0·239	0·295	0·441	
100	0·167	0·170	0·174	0·218	0·258	0·375	
5	0·033	0·039	0·048	0·106	0·200	0·371	Water.
10	0·029	0·032	0·037	0·073	0·118	0·331	
50	0·018	0·021	0·028	0·037	0·054	0·090	
100	0·018	0·019	0·020	0·030	0·042	0·069	

TABLE IV.

Cost of 1 horse-power hour in shillings with wire-rope transmission.

H.P. transmitted.	Distance in metres.						Prime mover.
	100	500	1,000	5,000	10,000	20,000	
5	0·094	0·122	0·157	0·456	0·868	1·899	Steam.
10	0·093	0·115	0·142	0·375	0·709	1·593	
50	0·090	0·098	0·108	0·212	0·376	0·925	
100	0·019	0·095	0·102	0·184	0·319	0·813	
5	0·009	0·016	0·025	0·104	0·207	0·406	Water.
10	0·008	0·014	0·021	0·080	0·159	0·333	
50	0·008	0·009	0·010	0·032	0·060	0·134	
100	0·007	0·008	0·909	0·023	0·042	0·099	

From these tables the author, whose name escapes my memory, concludes that in all cases where these four systems are equally applicable, wire-rope transmission is best for distances under 1 kilometre (1,100 yards), and electrical transmission for longer distances.

The following curves, which have been plotted from these tables, represent geometrically the relationship existing between these several methods of power transmission.

From these, and very many other things not here mentioned for want of time, which have already been accomplished, calculations have been based, and these show conclusively that it is possible to render available at every door any desired proportion, within reasonable limits, of the stored-up energy of our continent, in a form at once universally applicable, cheap, noiseless, cleanly, safe and manageable by unskilled hands.

All this is not only theoretically possible, but economically practicable. It is not of necessity simply a dream of a future Utopia. It may be made a realisation of the present—a grand every-day commercial experience.

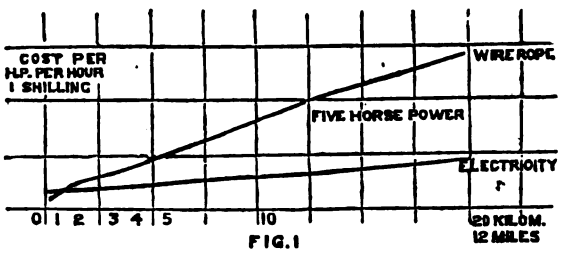

FIG. 1

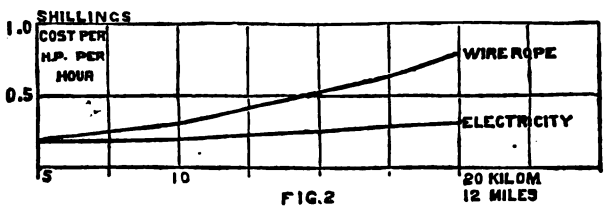

FIG. 2

It only requires that engineers generally and capitalists shall become conversant with these facts, to bring about a transition from the stage of practical *demonstration* to that of practical *application*. It seems strange, perhaps, to some of us, when we consider that these things have been demonstrated facts since the beginning of the present decade, that capital has not been directed in this channel ere this. Great scientific truths, however, become popularised very slowly. They require a long time to become a part of the current knowledge of mankind. Without doubt we all recall to mind how it was fully a century after Copernicus died before the Copernican theory was generally accepted by even the *learned*. And again, how from the time of Hero, who clearly set forth the principle of the modern steam engine, we find no historical evidence of its application to practical purposes for many centuries. Although John Fitch, in 1785, demonstrated beyond all question the feasibility of steam navigation, and worked indefatigably up to the time of his death, in 1798, for its introduction as a commercial feature of our country, it was not until 1807 that capitalists, appreciating the field open to them, came to the rescue, and assisted Fulton to make steam navigation an every-day commercial success; and even so worthy a scientist as he frequently endeavoured in vain to secure pecuniary countenance from the possessors of wealth and influence. With what force the frequently reiterated assertions of John Fitch come home to us now:—"The day will surely come when some one more powerful will get fame and riches from my invention, but no one will believe that poor John Fitch can do anything worthy of attention."

Let us hope the day for reproaches similar to those Fitch indulged in are past, and that capital, with its frequent similar experiences, backed by greater enlightenment and enterprise, will never again be wanting to prosecute schemes based upon scientific facts which bespeak untold wealth for their projectors and promise to confer manifold blessings upon mankind.

As I have already stated, the most important application of this principle of electric transmission of power is exemplified in the *modern* electric railway. Now, I advisedly use the expression *modern*, because the electric railway, like all other inventions, has a history. It is not a thing of spontaneous development, but of gradual growth. In considering its evolution, we must cursorily glance over the history of the "*electric engine*," as electro-dynamic machines have heretofore been christened. The earlier "electric engines" or motors belonged to that class or type known as oscillating or reciprocating engines. First to make an oscillating electric motor was a learned monk, strange to say, of Padua—Salvator del Negro, who, in the year 1881, succeeded in operating such a motor. An oscillating motor, however, has many disadvantages, the most important of which is the fact that the moving part (the "armature") at the end of its stroke is at a considerable distance from the attracting electro-magnet (the "field"). This, in electric motors, is a very serious defect, since the electro-magnetic attraction or pull diminishes in intensity very rapidly, varying, as it does, inversely as the square of the distance; so that when the armature begins to approach the field there will be very little, if any, force pulling it. Hence motors built upon this principle proved very

little more than pieces of physical apparatus. This first motor for producing rotary motion by electro-magnetism, without a reciprocating action, was invented in 1833 by our now deceased countryman, Professor Henry, late of the Smithsonian Institution, a description of which may be found in Vol. XX. of *Silliman's Journal*.

This motor also was but a toy, having the same defect just referred to, as indeed did all motors brought out up to the time of the discovery of the modern "dynamo" principle. Between the time of the advent of Henry's motor and the period of Professor Page's experiments, of which we shall learn further on, Davenport in our own country, Professor Jacobi in Russia, Davidson in Scotland, and Mr. Henry Little in England, constructed electric motors of considerable size. Professor Jacobi propelled a boat by electricity on the Neva, at St. Petersburg, in 1839; Davenport and Ransom Cook had quite respectable electric motors working in New York in 1840; and Davidson ran an electric locomotive in 1842 on a railroad near the city of Glasgow, Scotland. A little later Mr. Little operated an electric locomotive in England. Jacobi's motor was of about two horse-power; that of Davidson was a little over one horse-power, and propelled a locomotive weighing five tons at the rate of four miles an hour. Excitement upon this subject reigned supreme in New York about 1841, when electro-magnetic engines became a kind of mania, and although commercially worthless, hundreds of them were manufactured to meet the market demand.

The experiments of Jacobi, Davenport, and Davidson, proved unsatisfactory, however, as was predicted by contemporary scientists. This naturally caused disappointment and reaction; so that nothing of importance was added to the stock of knowledge concerning the subject until 1845, when Professor Page, of Salem, Mass., revived and gave to the subject a new impetus by the invention of a new form of electric engine based upon the principle of the axial force of electro-magnetism, which proved to be the most perfect electric motor ever invented up to that time. A few years later, Professor Page proposed electricity as a motive power for railroads, through the instrumentality of his own electric engine. This engine proved so successful and attracted so much attention that the idea gained favour to such an extent as to induce Congress to appropriate and place at Professor Page's disposal a sum of money (thirty thousand dollars) adequate to construct and operate an electric locomotive in accordance with his plans. Such a locomotive was built in 1851, and used to propel a train of cars between the cities of Washington and Bladensburg, a distance of five miles. As was natural, such an undertaking created great excitement and discussion in the scientific world, both at home and abroad, more especially because of the governmental sanction and assistance lent the enterprise. The great mathematician and scientist, Dr. Joule, and many others, very properly contended that the system would be too expensive, and that electricity as then generated, could not be used as a motive power with sufficient economy to warrant its adoption on a commercial scale. In fact it was this very discussion which led Dr. Joule to that long and laborious investigation of the mechanical equivalent of heat, which now forms the basis of all our work in thermo-dynamics, and without which we should be groping in the dark.

It was on the 29th day of April, 1851, that Dr. Page made the trial of his locomotive, which ran at the rate of 19 miles per hour, making the trip of 5 miles in 39 minutes. The locomotive itself weighed 10½ tons, including the batteries, and carried 7 passengers. There were many stops and delays on account of the breakage of his battery cells, which were carried upon the locomotive, the jars fulfilling the office of a steam locomotive boiler and furnace, zinc and sulphuric acid in the former case constituting the fuel. The sulphuric acid and zinc were burned or consumed in the production of electricity. This is the principle upon which it was sought to operate all the electric engines thus far referred to. Electricity was here called upon to serve as a prime motor, utilising the energy stored in sulphuric acid and zinc.

The folly of such an effort is manifest, since one pound of zinc costs twenty-five times more, and is not capable of being transformed into as much dynamic force as one pound of coal. Although Dr. Page's hopes were not realised as far as refers to the commercial aspect of the enterprise, he nevertheless accomplished a great feat, and to the day of his death he contended that the time would surely come when electricity would be economically used as a motive power upon railways.

Ever since Dr. Page's memorable experiment, thoughtful people have been looking expectantly and anxiously forward to the fulfilment of his prophecy. The time is now ripe for such fulfilment. In fact, it has even now passed from the stage of speculation and become *au fait accompli*, many miles of electric railway, notwithstanding their primeval crudity, now being in successful operation on a commercial scale in different parts of the world.*

You ask, I imagine, "What has rendered possible at this day that which was thirty years back demonstrated impracticable; and in what respect does the *modern* electric railway differ from that of the past?"

My answer is: that which has rendered the electric railway commercially feasible, is the discovery by Messrs. Varley, Siemens, and Wheatstone, and the subsequent development by many others, of the dynamo-electric machine; and the further discovery or demonstration by MM. Fontaine and Gramme of the reversibility of that machine, which admits of its being transformed into the most efficient form of an electric motor, when a suitable electric current is passed through it. The *difference* between the ancient and the modern electric railway consists in the fact that whereas the effort was formerly made to use electricity as a *primary* motive power originating from the consumption of zinc and acid, we now use the electric engine or electro-dynamic machine as a *secondary* motor, and the electric current simply as a means of *transmitting* power procured from natural sources or previously generated by any of the known economic methods, if some natural source of power is not at hand. Such a system contemplates the establishment of a central fixed station, where large steam boilers and engines of the most economic type are erected and used to set in operation dynamo-electric machines, which generate powerful currents of electricity. These currents are in turn transmitted through a copper conductor running along the roadway, and, by means of a moving contact, they are taken up into the cars while the latter are in motion, and there passed through an electric engine or electro-dynamic machine, which operates to propel the cars. This idea of the generation by dynamo-electric machines of powerful currents of electricity at stationary points, and the transmission of these electric currents to cars while in motion for the purpose of effecting their propulsion, was first put into execution in 1879, by Dr. Werner Siemens and myself, both of us working independently and mutually ignorant of the other's doings. I constructed a small model, such as was within my limited means, and used the same to demonstrate a lecture on electricity delivered at the time in Colorado Springs, Colorado; about the same time Dr. Siemens exhibited a more extensive model at the Paris Exposition.

In my system the method of applying the power was very different from that adopted by Dr. Siemens, my only object then being to demonstrate the principle of electric transmission of power to a moving car for the purpose of propelling the same. On receiving news of the work of Félix and Chrétien at the sugar plantation at Sermaize, they having resorted to electricity as a source of power for ploughing, I was more than ever impressed with the value of the system and of the future which lay before it, and I accordingly began experimenting upon and studying the subject up exhaustively, going thoroughly into every detail.

Although at the time actively engaged in medical practice, and connected with the Medical College in Denver, so great were the allurements, I was induced to give everything up in Colorado and leave there rather precipitately for Washington, in quest of a generic claim upon this fundamental principle. My case being examined, it was, however, found that the same principle had been *proposed* and provisionally patented, although not put in operation or even demonstrated and made public, as far back as 1840, by one Henry Pinkus, a remarkably inventive genius of that period. In 1840, however, the dynamo was unknown, and the electric car motors of Pinkus, which existed only in his imagination, were *supposed* to be operated by galvanic batteries buried in the ground. The principle of the transmission of the current to the car while in motion for the purpose of effecting its propulsion was, however, the same. The inventor even went so far as to anticipate the future use of "mechanical generators, which should be more economical" than the batteries.

Dr. Siemens and myself are consequently antedated as regards the question of first conception of this broad principle, and the underlying feature of the *modern* electric railway becomes public property. My application for a patent upon this fundamental principle is a matter of record in the United States Patent Office. This application was abandoned on discovering the record of the Pinkus patent. Appreciating, however, the rich harvest in store for inventors in this new field who should devise the most practical and economical means of applying this principle, which comprehends an army of important details, I immediately began research into the necessary conditions to a successful solution of this most intricate problem. The results of this investigation, which has cost many thousands of dollars, will, I hope, in your judgment, prove meritorious.

We may, of course, crudely mount upon a car a dynamo-electric machine of our own or another's design, and connect this up with the wheels or axles of the car by means of cog-wheels or belting, and thus effect the propulsion of the car, temporarily for exhibition purposes, regardless of the cost or of practical commercial requirements; as several have done since the first public exhibition of the modern electric railway by Dr. Siemens and myself, the individuals in each instance styling the result as "their electric railway," which, as a matter of fact, differed, figuratively speaking but by a bolt or a nut from Siemens's original road.

(TO BE CONTINUED.)

* Page's motor in operation and stereopticon views of the others were here introduced.

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COMPANIES' MEETINGS.

Special Meeting of the Compagnie Internationale des Telephones.

The special genera. meeting of shareholders in the above Company, called for deciding as to its reconstruction, was held at Brussels on 18th Dec., when M. Ed. Duchâteau, President of the Administrative Council, occupied the chair. The meeting was largely attended, about 49,000 shares being represented. The Chairman set forth summarily the conduct of the Administrative Council during the last period of its management of affairs, and called upon the shareholders, before discussing the measures which would terminate the Council's mission, to formulate an expression of their opinion as to the manner in which that body had discharged its duties. The following resolution was adopted by 26,152 to 4,588 votes (the administrators, who represented 15,025 votes, abstaining):—"The general meeting, after hearing the explanations of the President of the Council, formally approves of all the administrative acts hitherto performed by that body, and passes to the order of the day."

After the reading of the Council's report, the first resolution was adopted by 44,587 votes to 2,178:—"The following paragraph is added to Art. 29 of the Articles of Association: 'If the liquidator, duly authorised by the general meeting, brings as assets to another company the whole or a portion of the common property, and if he receives, as the price thereof, shares and promoters' interest in the new Company, the liquidation shall be effected, these promoters' shares being handed over to holders of sin ilar shares in the new Company, and the shares in the new Company, as well as the other bonds (*titres de portfeuille*) which might have been excluded from the assets brought to the new Company, being distributed among the shareholders, *pro rata* of the payments made.'"

The second resolution, carried by 42,603 to 1,637 votes, provides for the reconstruction of the Company in the following terms:—"The limited Company (Société Anonyme), known as the Compagnie Internationale des Téléphones, is disolved from this day, and will be wound up by a liquidator having the fullest powers, as determined by Articles 111, et seq., with power to constitute a company, and bring to it as assets all or a portion of the share property, in return for paid-up and promoters' shares, with power also to enter into all conventions for the liquidation of the liabilities, and to apportion the share capital in accordance with the terms of Article 29, as altered."

The third resolution appointed M. Adlerstein as liquidator, and M. Coene as assistant liquidator.

Australasian Electric Light, Power, and Storage Company (Limited).

The ordinary general meeting of the shareholders was held at the offices of the Company, 41, Coleman-street, on Tuesday, Mr. Latimer Clark, C.E., in the chair.

Mr. J. H. DUNCAN, F.C.A. (the secretary), read the notice convening the meeting, and also a letter from the auditors with regard to the stock in Australia, and in reply to a question, the Chairman said that the stock in Australia had been checked several times by the local auditors, and certified as being correct.

The CHAIRMAN said the shareholders would observe that the £3,000 which appeared as profit in the accounts from the Australian Company had not been treated as a profit. With regard to the £773 loss on Theatre Royal lighting installation, that contract had now been merged into a contract which was profitable, and they were writing that amount off at the rate of one-sixth every year; therefore they treated that £773 as a suspense account. He wished to explain why he occupied the chair to day. He was sorry to say that Mr. Want, who had hitherto so ably filled the chair, had found it necessary, from pressure of business, to resign the chairmanship, and in consequence he (Mr. Clark) had been requested to fill the chair to-day. He was sorry the report was not a pleasant one. There was no doubt the whole of the Company's large capital for payment of patents had practically turned out to be almost worthless upon the Company's hands. No doubt they all went into this enterprise at a moment of enthusiasm, the same as thousands of others did, under the impression that they were doing a good thing for themselves; but they had since learned that they had committed a great error. There was only one gleam of satisfaction, and that was that matters might have been very much worse. He himself applied for ten times the number of shares which were allotted to him, and he was glad they were not allotted; and if it had not have been for the enthusiasm which prevailed at the time, and the rush for shares, he should have had the whole amount he applied for, and should have been severely bitten for his pains. The Company expected to make a great fortune by the sale of concessions in Australia. At the time of the starting of this Company concessions for electric lighting could be sold for almost any sum, and it was thought that it was only necessary to send out concessions to Australia in order to sell them there. The Directors chose Sir Julius Vogel, whom they thought a competent man, who went out there, the Directors supposing that they would be able to sell the concessions freely. While Sir Julius Vogel was on his journey the whole bubble collapsed, and shares of these companies fell ruinously in price; and when Sir Julius Vogel reached his destination he found that telegrams had preceded him to Australia, telling the Australian people of the difficulties in this country. Sir Julius Vogel tried to sell concessions, but failed. The Directors pressed Sir Julius to form companies, and perhaps they pressed him too hardly, and he did form an Australian company, but arranged it in such a form that this parent company had to pay instalments on shares. Then he tried installations of electric lighting; in doing so they had incurred the greater part of the loss of £27,000. Sir Julius Vogel entered into contracts which the Company knew to be unprofitable, but which were intended to introduce electric lighting into Australia. As regarded the £27,000 to the debit of the Company, the shareholders must remember that if the Directors had chosen to "cook" the accounts, as it was commonly called, it would have been easy to make that loss appear less, because the greater part of that was really in the nature of advertising, and it would have been a justifiable thing to charge it to capital account, because it was really a case in which they had spent money in advertising the business. He wanted to divide the subject into two halves. He had referred to the past, and nothing could be more gloomy than that; but there was also the future, and he wanted to impress on their minds that the two were very distinct things. Everything had hitherto been against the Company. The Directors had written down everything to the lowest point, whereas they might have written much of it to a suspense account. But now he wanted to look to the future. The Directors, as regarded the future, still retained those hopes which they held last year when the shareholders were called together and their sanction obtained to an amalgamation with the Australian Electric Company. The Directors had many grounds for retaining those hopes. In the first place the business generally was reviving and was taking root rapidly, and, although not being executed by public companies, yet it was being executed by private firms to a great and profitable extent. The next point was that this Company was not bound to any particular system. The Company had paid enormous value for the Brush patents and also for the Sellon-Volckmar patent, but the Company was open to take up any other form of patent. Then, again, in Australia they had an excellent body of officers, and they had also a committee of management there, comprising three of the most influential men in Sydney, who were looking after the Company's interests there. The expenses in Australia were also being reduced. The accounts now presented were made up to June last, and up to that time they could not get all the contracts which had been made for the purpose of advertising and exhibition; but since then the Directors had been, and were still, getting rid of unprofitable contracts, and now they took in, and listened to nothing, which did not yield a profit. The Directors had placed in the hands of the shareholders a list of the works which had been executed. If they looked at the list they would find many losses and many profits. There was a heavy loss on the New Zealand contract; the other losses were temporary and were entered into for the purpose of illustrating the advantage of electric lighting. Therefore there were many matters for consolation. As regarded the Australian Electric Company, the accounts spoke for themselves. There was one great advantage which this Company had, and that was that the lighting had given great satisfaction in Australia, and there had been none of those breakdowns which had been heard of in this country. The Company had an excellent arc and incandescent light, and could do excellent lighting by both syetems. They had sent out a machine made by the Brush Company, and a Ferranti machine, which had worked with excellent results. There was no opposition to speak of. By amalgation with the Australian Electric Company they had done away with the opposition which compelled them to take these contracts at a loss. In Australia the expenses would be very different to what they appeared in the present accounts, and would in future be about £3,000 a year. The expenses in London would be about £1,500; therefore, in future the expenses would not be more than £4,500 altogether. The Directors had the strongest assurances from the agent on the other side that he saw his way, by business there, to meet expenses. If they earned £4,500 by the sale of £10,000 of plant, not only would they pay expenses, but also pay back some of the capital. They had £30,000 worth of plant in Australia, and if they could sell that they would get a considerable amount of money back. These were the chief features of the future. The Company was emerging from its heavy losses, and in the future the losses could not be of the magnitude and the kind which they now saw on the sheet before them. He could not congratulate them upon the position of the Company, but he thought the future was more hopeful than any one could suppose who merely took the balance-sheet and formed his opinion from that. They began with a large expenditure, under hopeful circumstances; the results were not what were expected, but he thought they had now been able to turn the helm and turn the Company's head towards port. In conclusion, the Chrirman moved the adoption of the report and accounts.

Mr. J. J. CATER seconded the motion, and said that negotiations had been going on for an amalgamation with the local Edison Company, and if this arrangement were carried out this Company would get rid of a formidable competitor in Australia, and their hands would be very much strengthened. He expressed his confidence in the future of electric lighting in Australia; he had never sold a single share in the Company, but had bought shares, which, at any rate, proved his belief in the undertaking.

Mr. STEPHENS, who said he was an original allottee, and the holder of 100 shares, moved that a committee of *bonâ fide* shareholders be appointed to inquire into and give a full and true account of the past history, present position, and future prospects of the Company, and also to ascertain whether by proper and economical management it was likely to succeed. He thought this should be ascertained before the remaining £1 per share was spent. As to the Directors, he had not that confidence in their management which would induce him to vote for their re-election.

Mr. BRANSCOMBE seconded the motion of Mr. Stephens. He asked for an explanation of the credited suspense account, £750.

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Mr. WAINWRIGHT thought the expenses of the London office, £465, were two high. The item of miscellaneous expenses, £360, required some explanation.

Mr. VAN TROMP said he thought the Directors would do well to consent to the appointment of a committee (who would not necessarily be hostile to the Board), who would inquire what the real position and prospects of the Company were, and whether further operations should be stopped, or whether the remaining one-fifth of the capital could be profitably expended or not.

Mr. INCE pointed out that the money which had hitherto been expended had been very much in the nature of an advertisement. For his own part he could not see that the Directors had done anything but what they believed to be in the interests of the Company.

Mr. LABOUCHERE said that the Company seemed to be beginning to turn the corner, and it would be a mistake not to adopt the report.

Mr. VAN TROMP asked whether the Board concurred in the appointment of a committee.

The CHAIRMAN said he very much appreciated the manner in which he resolution had been brought forward, but at the same time the minds of the Directors were made up on the subject. The Directors were not in accord with the mover and seconder of the resolution on this subject; he had no objection to the appointment of a committee, but it must not be as a committee of inquiry. If a committee of inquiry were appointed the Directors would refuse to be re-elected. The Directors had already said they would welcome shareholders on the Board, or a small consultative committee, but not a committee of inquiry.

A SHAREHOLDER: Would such committee have power to present a report?

The CHAIRMAN: Certainly.

The SECRETARY said that, judging from what came from a certain quarter of the room, there seemed to be a body of shareholders acting together for a specific object. He merely wished to draw attention to the fact.

A SHAREHOLDER said he thought the Directors had done the best they could for the Company, though no doubt there had been errors in the past.

Mr. INCE suggested that the proposed committee should be appointed to confer with the Directors, and not as a committee of inquiry.

Mr. A. J. LAMBERT said no doubt the Directors would be prepared to give every assistance to such a committee as suggested by Mr. Ince. Such a committee could obtain all the information required quite as well as a committee of investigation, and it was infinitely better on all accounts to adopt the suggestion of the last speaker rather than to get into antagonism with gentlemen who had been conducting a difficult and, up to the present time, an unfortunate business.

Mr. STEPHENS said he would modify his resolution as follows:—"That a committee of *bonâ fide* shareholders be appointed to confer with the Directors as to the past history and present and future prospects of the Company, and to report to a future meeting of the shareholders."

Mr. RAY seconded the motion, and said there was no suggestion of *mala fides* on the part of the Directors, but the shareholders simply wanted the present position and future prospects of the Company inquired into.

The resolution of Mr. Stephens was then put and carried, and Mr. Van Tromp, Mr. Pearson, Mr. Ince, Mr. Kisch, and Mr. Stephens were appointed the committee.

The CHAIRMAN, in reply to questions which had been put, said the Board were considering the desirability of acquiring the local Edison patents; if they acquired them they would not have to pay anything in the shape of cash, as the Company would be assisted by the willingness of the vendors to part with a portion of shares for that purpose. As regarded the Directors' fees, they had been placed to a suspense account, and would not be paid till the Company proved a success.

The SECRETARY explained the items in the accounts regarding which questions had been asked.

Some discussion then ensued as to whether the report and accounts should be adopted, and in the end the proposition for their adoption was negatived by 12 votes to 9.

In reply to a question, the CHAIRMAN said: The present Board will retain office nominally till a fresh Board is elected. We shall take steps to call another meeting.

On the motion of Mr. INCE, a vote of thanks was passed to the Chairman, and the meeting then closed.

Brush Midland Electric Light and Power Company (Limited and Reduced).

An extraordinary general meeting of the shareholders in the above Company was held on the 24th of December, at the offices, 4, Great Winchester-street, under the presidency of Mr. R. H. Glyn.

On the motion of the CHAIRMAN, seconded by Lord GREVILLE, the resolution passed at the former meeting, approving a conditional agreement between the Company and the Anglo-American Brush Electric Light Corporation (Limited), was confirmed; as was also the resolution passed on the same occasion, for winding up the Company voluntarily, under the provisions of the Companies Acts, the Chairman proposing, and Mr. Harrington seconding this motion.

A resolution was next submitted by Mr. HARRINGTON for the appointment, as liquidator of the Company, of Mr. Emile Garcke (secretary of the Anglo-American Company).

Mr. WYGRAM having seconded the motion, it was agreed to.

The proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. DEC. 31.		BUSINESS DONE WEEK ENDING DEC. 31. Highest.		Lowest.	
Anglo-American	30¼,	31½	.....	32½	.....	30½
Do. Preferred	54½,	55½	.....	56½	.....	54½
Do. Deferred	7⅞,	8¼	.....	8⅜	.....	8¼
Brazilian Submarine	10⅞,	11	.....	10⅞	.....	— x.d.
Cuba	11,	11½	.....	11⅝	.....	—
Do. Preference	17,	18	.....	—	.....	—
Direct Spanish	3,	3½	.....	—	.....	—
Do. Preference	13½,	14	.....	—	.....	—
Direct United States Cable	9⅜,	9⅝	.....	9⅝	.....	9 3-16
Eastern Telegraph	11⅞,	12	.....	12	.....	11⅞
Do. 6 per Cent. Preference	13⅞,	14½	.....	14	.....	—
Do. 5 per Cent. Debentures, 1899	104,	107	.....	106½	.....	—
Eastern Extension	12½,	12⅝	.....	12½	.....	12⅝
German Union	9¾,	10½	.....	—	.....	—
Globe Telegraph and Trust	7⅛,	7⅜	.....	7⅜	.....	7⅛
Do. Preference	12⅜,	12⅝	.....	12 13-16	.....	12⅝
Great Northern	14⅜,	14⅝	.....	14 13-16	.....	—
Indo-European	32,	33	.....	—	.....	—
Reuter's	7½,	7⅞	.....	—	.....	—
Submarine	175,	180	.....	178	.....	—
West India and Panama	⅜,	1	.....	—	.....	—
Do. 1st Preference	7½,	7⅞	.....	—	.....	—
Western Brazilian	6⅜,	6⅝	.....	6 13-16	.....	—
Western Union 7 per Cent. 1st Mortgage	120,	125	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	.....	—	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅜,	½	.....	—	.....	—
Oriental	½,	⅝	.....	—	.....	—
United Telephone	11½,	12	.....	12 3-16	.....	11 13-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	.....	—	.....	
Do. (fully paid)	3½,	3¾	.....	—	.....	—
Hammond Light (£3 15s. paid)	⅜,	½	.....	½	.....	½
Swan	½,	⅝	.....	⅝	.....	—
Maxim-Weston	⅛,	¼	.....	—	.....	—

MISCELLANEOUS.

Telegraph Construction	35,	36	.....	35½	.....	—
India Rubber, Gutta Percha, and Telegraph Works	22½,	23½	.....	23	.....	—

ESTIMATES are desired for FITTING ELECTRIC BELLS to 18 and also to 32 Rooms, with Apparatus to Show in which Room Bell was Rung. Address the Secretary, Junior Mess, R. N. College, Greenwich.

GOOD LINESMEN WANTED, for running incandescent circuits.—Apply to WOODHOUSE and RAWSON, 11, Queen Victoria-street, E.C., 11 a.m., Monday, January 5th.

THE NEW VALVE

FOR CIRCULATING AND AIR PUMPS.

Steamship Owners and Engineers should acquaint themselves with the superiority of Valves manufactured from the

PATENT VULCANISED FIBRE

As against all others in the market. 100 per cent. cheaper than Rubber. Reliable testimony can be shown as to the working of these Valves.

MOSSES & MITCHELL, Sole Agents for the Patent Vulcanised Fibre,

68, 69, 70, & 71, CHISWELL STREET, LONDON, E.C.

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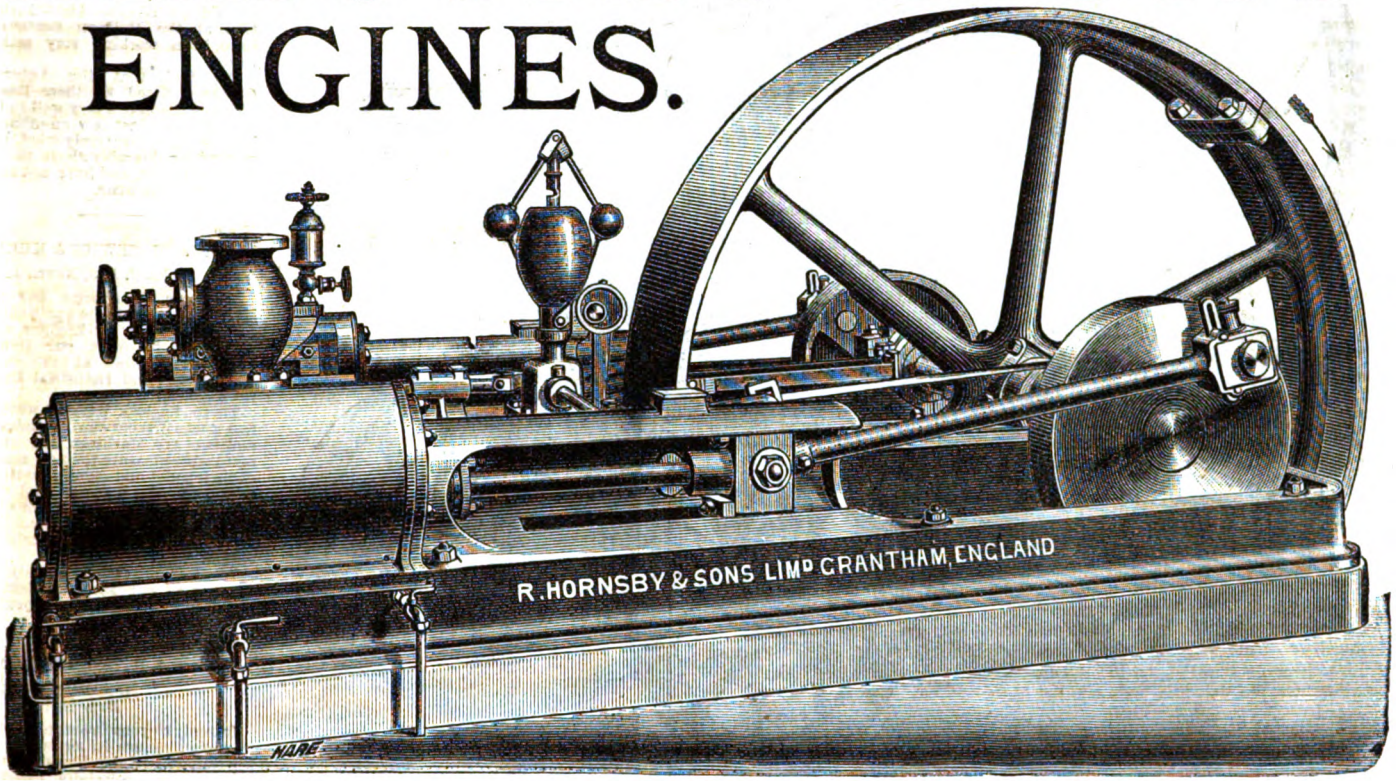
R. HORNSBY and SONS (Limited).

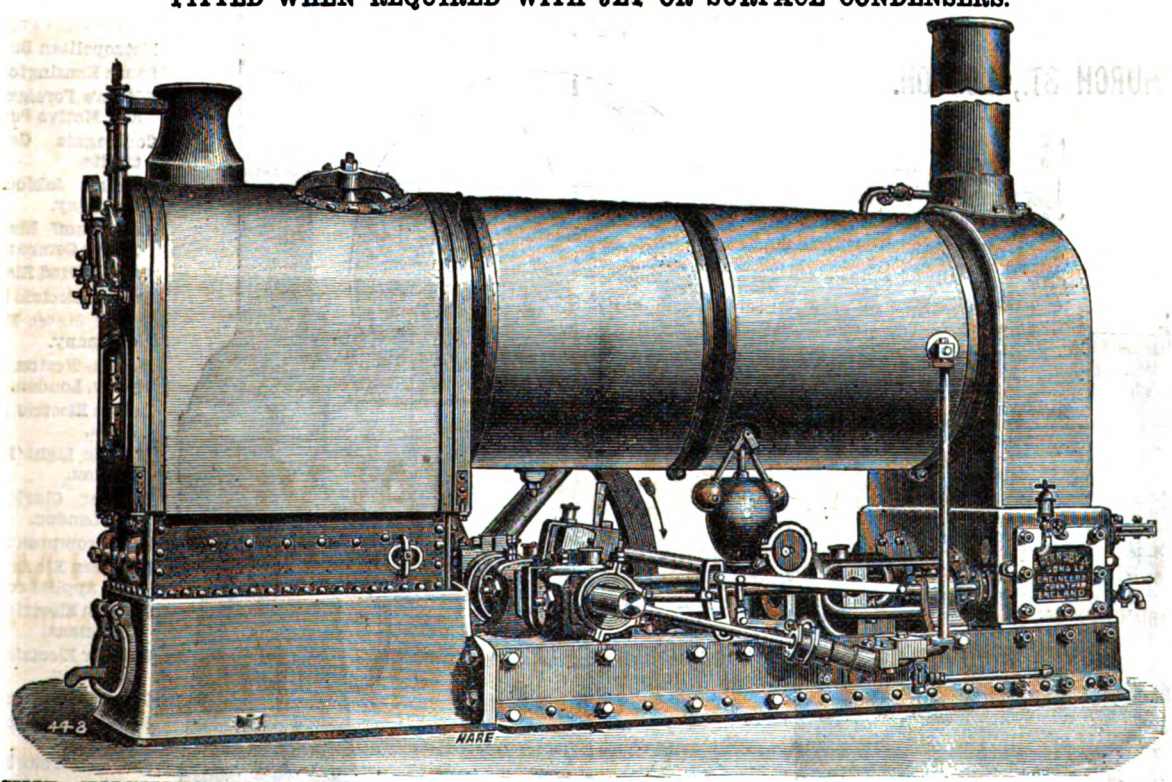
ELECTRIC LIGHT ENGINES.



STATIONARY ENGINES - - { **8 to 50 H.-P. Single Cylinder.**
16 to 100 H.-P. Double Cylinder.

FITTED WHEN REQUIRED WITH JET OR SURFACE CONDENSERS.

Full Descriptive Catalogues



Gratis and Post free on Application.

COMPOUND ENGINES, 6 to 50 H.-P., either arranged as above or with Boiler detached from Engine, and fitted when required with Jet or Surface Condensers.

SPITTLEGATE IRON WORKS, GRANTHAM.

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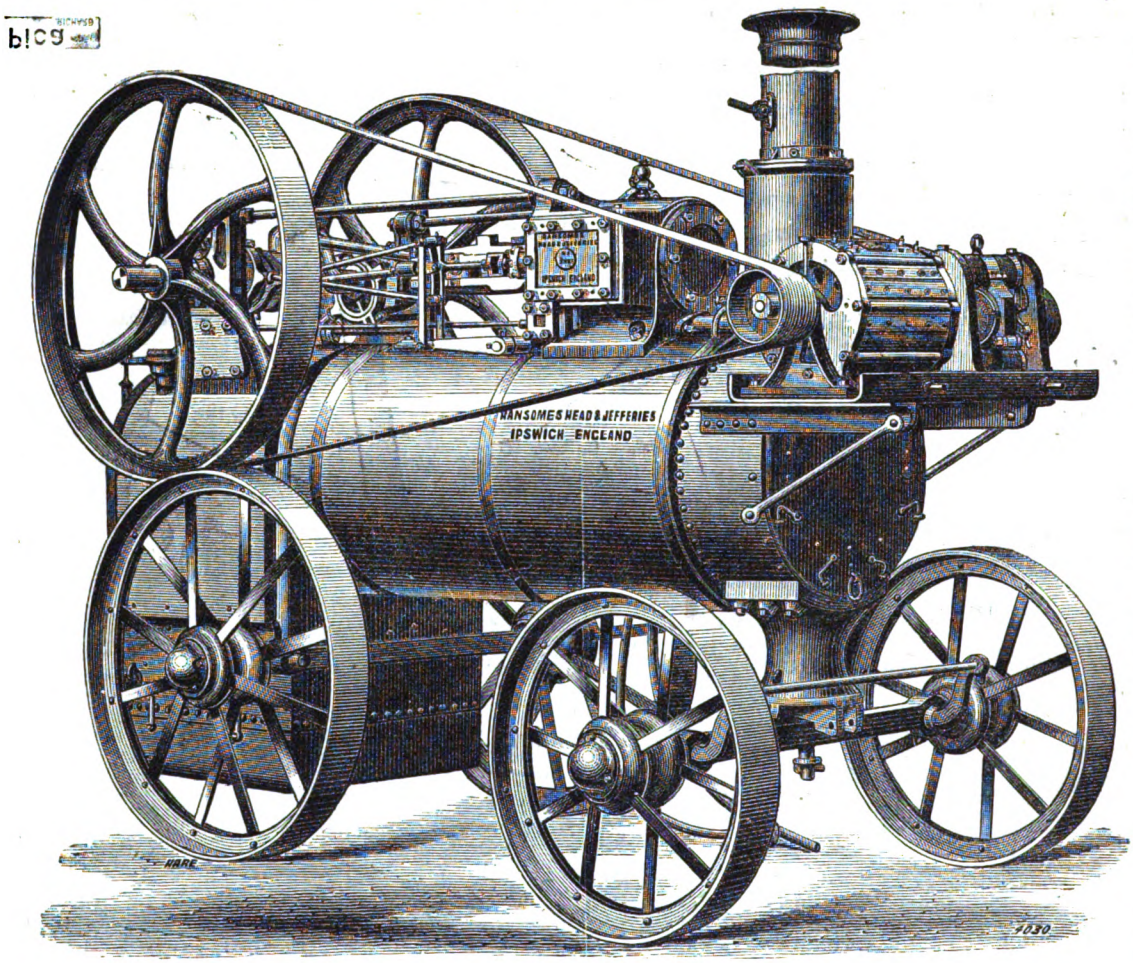
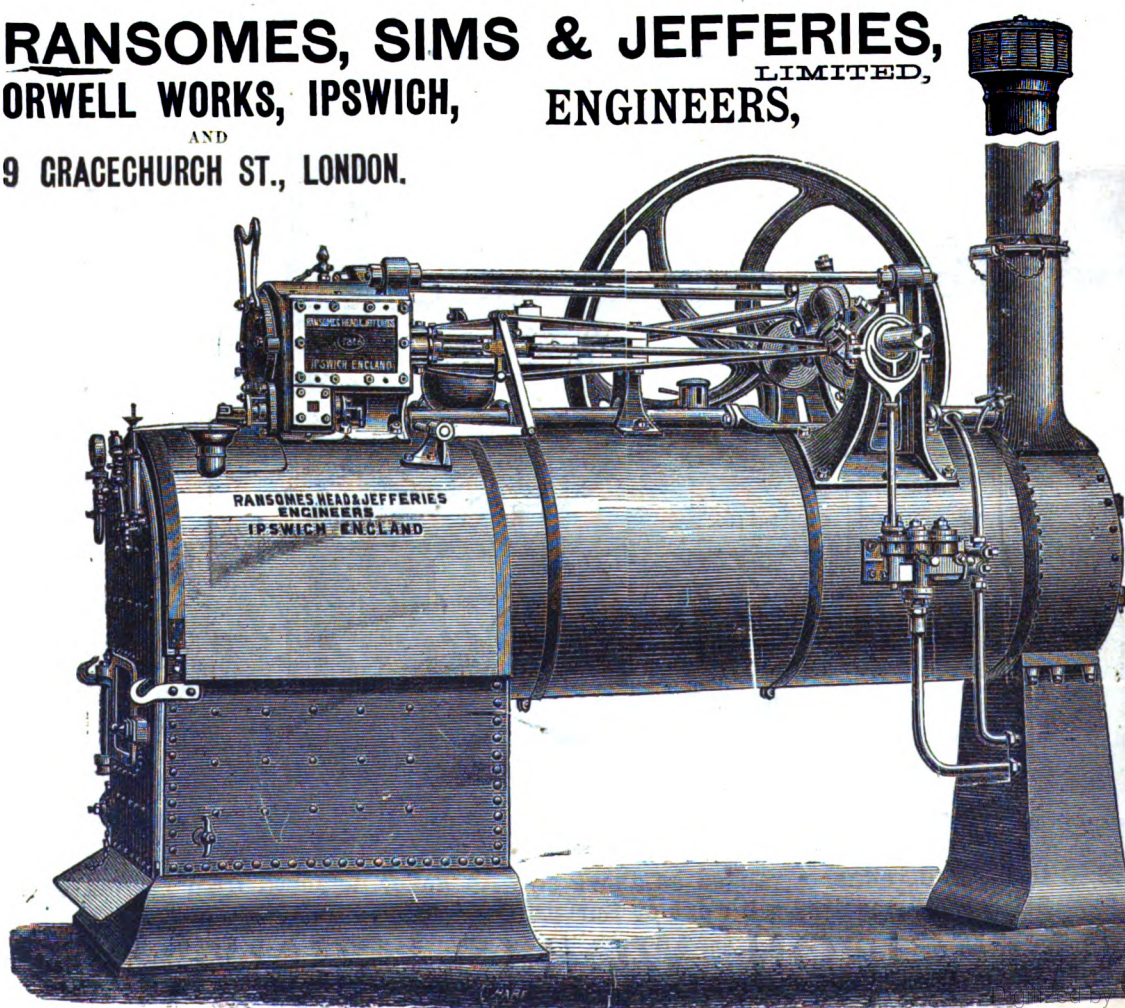


RANSOMES, SIMS & JEFFERIES,

ORWELL WORKS, IPSWICH, LIMITED, ENGINEERS,

AND

9 GRACECHURCH ST., LONDON.



TESTIMONIALS.

From
Messrs. LEWIS OLRICK & CO.,
27, Leadenhall-street, London, E.C., Jan. 8th, 1884.

We have pleasure in stating that the two 16 H.-P. Engines you supplied in February of last year for the Edison Electric Light Installation at the Holborn Restaurant, have been working very satisfactorily.

We find that the Automatic Governor fitted to these Engines controls the speed very well indeed.

During the last few months they have been very severely tried, being worked considerably above the guaranteed power, and have not shown signs of undue wear.

From
Messrs. OLSZEWICZ & KERN,
Kieff, 1/13, Novr., 1884.

We have to express our most sincere thanks for the excellent performance of your two Engines, which were used to drive our Dynamo Electric Machines at the Odessa Agricultural and Industrial Exhibition.

These Engines were at work for five weeks driving one Incandescent and two Arc Machines, and we can state with pleasure that on account of their quiet and regular motion, as well as by the accurate and quick action of the Governor, they have proved themselves to be excellent Motors for Dynamo Electric Machines.

We shall not fail to employ your Engines in our Electric Light Installations as frequently as possible.

From
Messrs. J. H. HOLMES & CO.,
Newcastle-on-Tyne, Dec. 22, 1884.

In reply to your favour of the 15th, we have pleasure in reporting that the 6 H.-P. Portable Engine you supplied to us, specially fitted for Electric Light purposes, has given every satisfaction, and we consider it a very good Engine.

RANSOMES, SIMS, AND JEFFERIES (Limited) have also supplied their Electric Light Engines to—

Metropolitan Board of Works.
South Kensington Museum.
Edison's Foreign Electric Light and Motive Power Co.
Compagnie Generale d'Electricite.
Russian Jablochkoff Electric Company.
Jablochkoff Electric Light and Power Company.
Swan United Electric Light Co.
British Electric Light Company.
United States Electric Lighting Company.
Maxim-Weston Electric Company, London.
Indian Electric Light Company, Paris.
Electric Light Engineering Co., London.
Latimer Clark, Muirhead and Co., London.
R. E. Crompton and Co., London.
Northern Electric Light, Power, and Appliances Company.
Spanish Electric Light Company, Barcelona.
Gulcher Electric Light & Power Company.
Great Eastern Railway Co.
Royal Humbert Amphitheatre, Rome.
And numerous Private Firms.

Special Catalogues, Prices, and every information on application.

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NOTES.

WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the month ended 31st Dec. were £3,790.

SOCIETE GENERALE DES TELEPHONES.—The paid-up 375f. shares in this company stood at 385 on 29th December, but rose to 390 on 5th inst.

THE TELEGRAPH IN SPAIN.—The military telegraph system of Spain is about to be reorganised and extended, and the latest improvements adopted.

WORKS LIGHTING.—Messrs. Sharp, Stewart, and Co., Manchester, have decided to light their works by electricity. Mr. F. D'A. Goold will carry out the work.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts for the month of December were £1,738 against £1,473 in the corresponding period of last year.

LIGHTNING.—During a recent thunderstorm, the steamer "Easby," while off Wilson's Promontory, Victoria, was struck by lightning; but fortunately did not sustain much damage.

THE EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1884, amounted to £53,036, and to £49,181 in the corresponding period of 1883.

TELEGRAPH INSTRUMENTS IN FRANCE.—It is stated that there are no less than 7,702 Morse instruments in operation in France, and that the Boudet instrument transmits 1,800 telegrams daily.

ELECTRIC LIGHT IN THE SKATING RINK.—Two Berlin skating rinks, one in the Karlstrasse, and the other in the Pionnierstrasse, are electrically lighted, the former on the Brush arc system.

LECTURES ON ELECTRICITY.—Two lectures on electricity have been delivered at the London Institution, Finsbury-circus, by Professor O. J. Lodge, of University College, Liverpool, to crowded audiences.

ASKABAD-MERV-SARRACKHS TELEGRAPH LINE.—The Russian Government is reported to have apportioned a sum of 100,000 roubles for the immediate erection of a telegraph line from Askabad to Merv and Sarrackhs.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 31st Dec. are £2,278, as compared with £2,314 in the corresponding period of 1883.

PARIS TELEGRAPH STAFF.—The number of lady clerks in the Bourse telegraph office, Paris, has been reduced; and it is thought that, by a judicious redistribution of duties, the work may be performed by two-thirds of the staff as now reduced.

ELECTRIC LIGHT IN THE HOSPITAL.—We learn that the wards of the new female hospital, Berlin, are lighted by 96 incandescent lamps, only 72 of which, however, are in action at one time, the motive power being supplied by a 9-horse steam engine.

ELECTRIC LIGHT IN HOLLAND.—It is reported that there is an idea of electrically lighting the Hollandsche Haafen, near Rotterdam, by means of accumulators. But why, in the name of common sense, by accumulators, instead of by current generated direct?

ELECTRIC LIGHT AT LANARK.—Permanent electric lighting arrangements have recently been made in the small town of Lanark, the business premises of Messrs. Hunter and M'Morrison, ironmongers, having been completely fitted up with incandescent lamps.

PLANTE ACCUMULATORS.—M. Planté has now made some accumulators in which the lead plates assume a horizontal position, and having a contact piece turned up at right angles. With this arrangement there is no difficulty in rolling, nor of the plates bending and coming into contact.

EASTERN EXTENSION, AUSTRALASIAN, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1884, including all Government subsidies, amounted to £41,426, and to £35,335 in the corresponding period of 1883; increase, £6,091.

"L'ECLAIRAGE ELECTRIQUE."—At the ordinary general meeting of this company, held at Paris on 29th December, M. Hippolyte Fontaine, president of the Administrative Council, in the chair, the accounts were passed; and it was shown that the profits on last year's working amount to 185,587f. (£7,423).

ELECTRICAL MISSION.—The scientific men, including M. D. Napoli, M. G. Duché, M. A. Guerout, and M. Bertrand, sent by *La Lumière Electrique* on a mission to study electrical progress in various parts of the world, have returned to Paris, after visiting Canada and the United States, Mexico and the Antilles.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of December, 1884, amounted to £19,000. From 1st January to 31st December, 1884, they amounted to £276,280; in the corresponding months of 1883 to £254,488; and in the corresponding months of 1882 to £241,373.

APPLICATION OF STATIC ELECTRICITY TO THE HEALING ART.—The *Wiener Elektrotechnischen Zeitschrift* says that the Scientific Examining Committee of the late Vienna Electrical Exhibition talks of the application of static electricity to medical purposes; but the *Centralblatt für Elektrotechnik* asks how *static* electricity can be *applied* at all.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of December was 3,001, estimated to produce £2,500, against 2,774 messages, producing £2,559, in the corresponding month of last year. The traffic receipts for the month of September, estimated at £2,150, realised £2,163.

NEW BATTERY.—M. de Sainte Marie makes the positive pole of lead surrounded by chlorate of lead, and the negative pole of zinc, while the liquid contains chloride of lead, presumably for diminishing the resistance. Under the influence of the electric current, the chlorate of lead is reduced to metallic lead, which is deposited in the form of sponge.

THE EARTHQUAKES IN SPAIN.—A telegram from Naples states that Professor Galli, of the Observatory at Velletri, reports the interesting facts that at the time of the earthquakes in Spain almost continuous oscillations were registered by his new and very sensitive instruments, and that from the 28th ultimo to 3rd inst. no less than 200 shocks took place.

ELECTRICITY V. GAS IN SCHOOLS.—During the discussion, by the Paris Municipal Council, of the Primary School budget, a petition was presented requesting the Administration to study suppression of gas in the schools and colleges, and the adoption of electric light. If this is found impracticable, the petitioner, M. Lyon-Alemand, advises a return to oil lamps.

UNIVERSITY COLLEGE, BRISTOL.—The second term of the department of Experimental Physics at this college will begin on 16th inst., under Professor S. P. Thompson, D.Sc., B.A. Lectures and classes in Experimental Physics will be given to first, second, and third year students. The physical and

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electrical laboratory is open daily, and also on Wednesday evenings.

INSTITUTION OF CIVIL ENGINEERS.—The new president of the Institution of Civil Engineers, Sir Frederick Bramwell, F.R.S., will deliver his inaugural address at the meeting of the society next week. Sir Frederick is also chairman of the Executive Council of the Inventions Exhibition, and it is understood that engineering inventions since 1862 will be the subject of his remarks.

ELECTROTECHNIC HANDBOOK.—In connection with the Munich *Centralblatt für Elektrotechnik*, Herr R. Oldenbourg, of Munich and Leipsic, is publishing, for the second year, his "Kalender für Elektrotechniker," a guide and handbook for electricians. The contents are arranged under the six heads of Mathematics, Mechanics, Physics, Machinery, Electrotechnics, and items of everyday use.

ELECTRIC LIGHT AT THE PARIS OPERA.—The number of electric lamps at the Opera House, Paris, has been increased to 32 Edison arc lights and 6 Cance arcs, the latter being placed inside the chandelier, so as not to dazzle the eyes of spectators, while giving a considerable amount of light. A trial of the additional lamps has given satisfactory results; and they will be brought into requisition at the first performance of "Tabarin."

TELEGRAPH TO THE FASTNET ROCK.—The steamer "Kangaroo," belonging to the Telegraph Construction and Maintenance Company, sailed from the Royal Albert Dock, London, on Saturday, having on board the cable which is to connect Lloyd's signal station on the Fastnet rock with the Postal Telegraph Office at Crookhaven, county Cork. The work of laying the cable will be carried out as quickly as the weather permits.

"BULLETIN INTERNATIONAL DES TELEPHONES."—This is the title of the successor to the *bulletin* of the Compagnie Internationale des Téléphones, which, like the company itself, has been reconstituted. Our contemporary is increased in size without changing complexion, so that it will, in all likelihood, not cease to be familiarly, but irreverently, designated the "P'tit Bleu." The editorial department declares categorically that the paper will maintain its strict impartiality.

ELECTRIC LIGHT IN THE RESTAURANT.—*L'Electricité* of last week illustrates, *more suo*, the newly opened restaurant of the Krasnopolski beer hall in the Warmse-straat, Amsterdam, brilliantly lighted by Edison incandescents enclosed in opal glass tulips. This system of lighting has replaced the Siemens arc, which was found intense enough, but not sufficiently steady. Now, adds our contemporary, a stay in the restaurant is a *vraie fête pour les yeux*, favourably disposing the *convives* to gastronomic joys, while affording them a *consommation* much more necessary to existence than the choicest viands and most refreshing beverages—viz., respirable air *à discretion*.

CONVERSION OF LIQUID INTO DRY BATTERIES.—According to Onimus, batteries containing solution of ammonium chloride, zinc chloride, &c., may be converted into dry piles by mixing these solutions with plaster of Paris and allowing the mixture to solidify. If mixtures of ferric oxide or manganese peroxide with plaster of Paris are employed, the electromotive force is slightly higher than with plaster of Paris alone, and when ferric oxide is used the battery quickly regains its original electromotive force when the circuit is broken. When the battery is exhausted the solid plaster is simply again moistened with the solution.—*Jour. Chem. Soc.*

THE CREIL EXPERIMENTS.—It appears from the work of M. Vivarez, on the construction of overhead electric leads, that the silicious bronze cable for transmitting the current from Creil to Paris will be 75 kilometres = 46½ miles long, and weigh 20 to 25 tons. The resistance will not exceed 100 ohms; and if the current be 20 amperes at 7,500 volts, the loss of energy due to the conductor will be about $\frac{100 \times 400}{10} = 4{,}000$ kilogrammetres = 50 horse-power. If the external resistance be half the total resistance, there will be a theoretical useful effect of 50 per cent. of the power absorbed by the generator.

LIGHTING SHOW ROOMS.—A part of the show rooms of Mr. T. Briggs, Leeds, is lighted by an arc lamp. This lamp displaces eighteen gas burners, each consuming 4ft. per hour, and gives a much better light than the old system. The lamp is worked by an "A" Gramme machine driven by the "Otto" gas engine at the works about 100 yards away. The current of eighteen amperes at forty-five volts is carried along overhead wires of silicium bronze. The actual cost, including gas, carbons, oil, &c., is 2½d. per hour, which is only slightly in excess of the cost of gas previously consumed. It is a fact worthy of note that this is the first arc installation used for shop lighting in Leeds.

LIGHTNING CONDUCTORS AT AMIENS CATHEDRAL.—After the storm, with globular lightning, which occurred at Amiens on 24th Feb., 1884, M. C. Decharme called attention to the defective state of the lightning conductors on the Cathedral. That for protecting the spire had no terminal point, two visible breaks in the continuity of the iron conductor, and insufficient earth connection, made by the simple prolongation of the conductor into the soil, which always remained dry. The Administration of Historic Monuments has now, however, had all the *paratonneres* overhauled and connected together by large copper conductors, put in communication with galvanised iron plates of considerable area, immersed in the water of two wells.

NEW ORLEANS.—The New Orleans Council Committee on Fire Department and Lighting has decided to accept the proposition of the South Western Brush Electric Light Company, for one year, to furnish 113 electric lights of 2,000 candle-power each, to burn all night and every night, for 16,019.56 dollars. This is stated to be the exact cost to the city of lighting by the gas and oil lamps which the electric lamps will displace. The Gaslight Company declares that it will charge the city for every gas lamp now in use, whether any of them will be replaced by the electric light or not. A proposition of the Gaslight Company to light the municipal buildings, furnishing 20-candle lights at 1 cent. per hour each, has been accepted by the committee.

OIL WORKS LIGHTED BY ELECTRICITY.—The Pumpherston Oil Company, near Uphall, N.B., having decided to light their premises, entrusted the work to Messrs. Henry Bennett and Co., Glasgow, who have fixed the necessary apparatus for five arc lamps. The dynamo is placed in the fan engine house, and is driven by the same engine as the fan, which has been fitted for the purpose with a sensitive governor. The lamps are hoisted on poles 45 to 50ft. high, and the total length of circuit is about 750 yards. One lamp lights the "tip" for the burnt shale, another the retorts, a third at sulphate house lights the surrounding place, a fourth is placed so as to command the stills, and a fifth the space adjoining the refinery, including a range of steam boilers. The lights enable the outdoor work to be carried on all night as well as in daylight.

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UNIVERSITY SCIENCE LECTURES.—The following are among the courses of twelve weekly lectures which will be given in connection with the London Society for the Extension of University Teaching during the January to April term :—Dr. J. W. Waghorn, R.M.D.Sc., will lecture on "Light," at Whitechapel, and on "Electricity," at the Bank of England and New Cross; Mr. F. W. Rudler, F.G.S., on "Geology," at Croydon; and Mr. Walter Pye, F.R.C.S., on "Human Physiology," at Blackheath and Whitechapel. The lectures are accompanied by class teaching, and an optional examination (in writing) is held at the end of each course by independent examiners, appointed by a joint Board of the Universities of Oxford, Cambridge, and London. On the results of this examination the Universities' Board awards first and second class certificates.

ELECTRIC POWER AT THE LOUVRE.—Most visitors to Paris know that, if they purchase goods to a certain amount at the Magazins du Louvre, they receive a small india-rubber balloon, stamped with the word "Louvre," which serves the double purpose of amusing the children and advertising the said gigantic drapery establishment. Now, the air-pumps, which inflate the hundreds and thousands of balloons, require a certain amount of power; and the many sewing machines, a still greater amount. For these two purposes, the Compagnie Electrique has installed one of their No. 5 generators, with a No. 5 normal motor for driving the sewing machines, and a No. 3 motor for the air-pumps; and at the branch establishment in the Avenue Rapp, a generator and two motors have been put down for driving the sewing machines. The *Bulletin International des Téléphones* says that the working leaves nothing to be desired.

PAROD'S ACCUMULATOR.—In the accumulator of M. Parod, the plates, instead of being simply composed of lead sheets, like those of Planté, contain a copper core, hermetically enclosed in a leaden cover, which constitutes the secondary plate proper, and which alone comes in contact with the exciting liquid. In the middle of this core, which is a good conductor, the primary current unites, simultaneously, all the secondary plates, every portion of which develops an equal electro-galvanic action. The absorption of the primary current is therefore excessively rapid and regular, and the formation uniform. These secondary plates with conducting core, which are capable of any form and arrangement, are contained in a cell of ebonite or other similar material, divided into two parts by a porous diaphragm, in such a manner as to avoid the oxidation of the electrodes and the transposition of the salts.—*Il Giorno, Rivista dell' Elettricità.*

ELECTRIC LIGHT AT THE ANTWERP EXHIBITION.—With respect to our note of last week, the general secretary writes us that it is not desired that one system only shall be shown; but, on the contrary, the Special Committee formed to study the question of lighting the palace and grounds, are en leavouring to get representatives of the various systems known to compete for the illumination of an area not less than 115,000 square metres in extent. Electrical engineers and electric lighting companies, English included, are invited to make offers for lighting various portions, so as to give an opportunity for judging of the merits of each. Side by side with the applications of the latest improvements in electric lighting, it will be very interesting to see the improvements that the gas companies have been compelled to make in order to fight their triumphant enemy. The Special Committee aforenamed will also admit any other system of lighting, perhaps better suited for certain cases.

POWER IN SWITZERLAND.—*La Lumière Electrique* reports that, at the town of Bienne, in Switzerland, near which the waterfalls are capable of yielding a power equal to that of several thousand horses, two dynamos, connected by an overhead line, consisting of two 7mm. copper wires, are installed, one near the fall and the other in the town, a distance of 1,250 metres, or nearly a mile. The generating dynamo is driven by a turbine, which also serves to set in motion some neighbouring machinery, while the receiver supplies current to two works requiring very different powers. In one, where silver is rolled, the power required is very variable; while in the other, where parts of watches are made, a uniform speed is absolutely necessary. A compound winding of the electrical machine has therefore been adopted, so that the speed remains constant whatever be the power required. The installation was effected by Meuron et Cuénod, of Geneva, with Thury dynamos, and has worked regularly for nearly a year.

THE TELEPHONE IN PARIS.—The *Pall Mall Gazette* says that New Year's Day in Paris witnessed the inauguration of an important postal reform, five telephone bureaux being opened at well-chosen centres of business or population. The Bank was necessarily the most important, and the office of the Grand Hotel gave the greatest facilities to strangers; but Parisians in all directions could avail themselves of the offices temporarily opened near the Madeleine, in the Rue de Grenelle, on the Boulevard Malesherbes, and in the great centre of the Halles, the use of these offices not being restricted to subscribers. The public had access to all of them, and the scale of payment was fixed by time, half a franc securing five minutes' uninterrupted conversation, with the privilege of rateable protraction of the time. It is proposed to forthwith increase the number of offices, so that the more important telegraph offices in the city shall be put in communication; in fact, the telephone will be made complementary to the pneumatic post.

TRAIN HEATING BY ELECTRICITY.—Referring to our recent note on this subject, we glean some more detailed information from the *Bul. Int. des Tel.*:—In this system, devised by M. Em. Courcelles and M. Alph. Elu, the heat is produced by the current passing through a certain number of small lead plates arranged transversely in an ordinary foot-warmer. The plates are all in a shunt circuit, the current, led by two iron wires, being thus evenly distributed. In the trials which took place at M. de Meritens' works, the current was generated by a Gramme machine and traversed five foot-warmers, 1·8 metre long, 22cm. wide and 5cm. thick (71 × 9 × 2in.) coupled in series. The current was 50 volts at 24 amperes at the terminals of the dynamo, so that the energy given out was about 1½ horse-power per second. Consequently, *le jeu ne vaut pas la chandelle*; but in another arrangement, patented by M. Thommasi about a year ago, the current passes through spiral metallic conductors in each foot-warmer, previously filled with some substance possessing great latent heat on melting, such as crystallised acetate of lead or hyposulphate of soda, and plunged into boiling water before starting.

TOMMASI'S HEAT INDICATOR.—For giving warning automatically of any undue heating in an electric conductor, M. Tommasi has invented an instrument consisting of a wooden block with cylindrical hole, fitted with a spiral spring, which supports a small copper cup, filled with stearine or paraffin. A short copper wire is bent angularly so as to project above the cup, the part which projects resting on the stearine, but in its absence on the cup, thus making contact. The short copper wire is put in the circuit by two binding screws, one of which, as also the spiral spring, is connected with an interposed bell, in a local circuit with separate battery. Between the two binding screws and above the instrument is

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an incandescent lamp with coloured glass, which is switched into a shunt circuit, and also connected with the metal cup. The instrument is placed near the dynamo, and the bent copper wire is interposed in one of the leads near its junction with the machine. When the temperature of the lead reaches 60° C. = 140° F., the copper wire melts the stearine and makes contact with the cup, closing the bell circuit, and also that of the incandescent lamp, thus giving two warnings, one to the sight and the other to the hearing.

Electrical Conductivity of Weak Saline Solutions.—The electrical conductivity of the salts dissolved in water varies with the degree of concentration in a very complex manner, and differs between one salt and another, there being no general law or empirical formula of any considerable application. At first sight it might be conceived that this conductibility depends both on the chemical nature of the salt, on the hydrates which it is capable of forming, and on their stability. Experience also establishes the fact that it is not unconnected with some of the physical properties of the solution, and especially with its degree of viscoscity; but the precise proportion of these various influences has not yet been determined. It appeared to M. E. Bouty that there was reason, in the first place, to simplify the problem by only dealing with solutions having identical physical properties. He therefore experimented with solutions so diluted that their density and their viscoscity were the same as those of pure water, while their conductivity was relatively enormous as compared with that of water, being easily measured by an electric method founded on that of M. Lippmann.

Measure of Intense Light.—Before the Paris Academy of Science, the other day, M. A. Crova dealt with the photometric value of an intense focus of light (solar or electric), the determination of which, he considers, requires the practical realisation of the following conditions:—(1) Comparison of two lights of different tints; (2) valuation of the tint by means of a numerical factor; (3) determination of the photometric ratio of a very intense source as the function of a relatively feeble standard. The first condition may be realised by using a solution of perchlorate of iron and chlorate of nickel, across which the photometric screen is observed. In practice, the tint may be represented by means of two successive photometric determinations: one, obtained by observing Foucault's photometric screen through the solution 580, gives the ratio of the intensities; and the other, made by placing before the eye a glass reddened by oxide of copper, which lets pass radiations comprised between 726 μ and 752 μ, with a maximum of 650 μ, gives a ratio so much inferior to the former as the tint of the light compared with the carcel flame is whiter. The quotient of the former determination by the second permits of distinguishing the tint, which is so much greater as the light is whiter. Lastly, the third condition may easily be realised by the use of a special photometer.

The Stock Exchange.—On Tuesday, a large number of invitations were issued to visit the new extension buildings of the Stock Exchange, and see an experimental lighting of the place by electricity. The lighting has been carried out by Messrs. Woodhouse and Rawson, who have made the most of the space at their command, so far as the machine room is concerned. We should, perhaps, apply a term to the apparatus not unknown in Stock Exchange parlance, and say it was completely "cornered." Two field boilers supply steam to two of Willans' high-speed compound engines, which drive two Elwell-Parker dynamos. A third dynamo is held in reserve, and can be driven by either engine. If necessary, either of the boilers can supply both engines, or at a push one engine will drive the dynamos; so that the machinery is really in duplicate, thus obviating the danger of a total break-down. The main hall of the new building, which is octagonal in shape, carries a dome 70ft. in diameter. On the cornices, at the spring of the dome, specially designed wrought-iron standards are placed. These standards carry Woodhouse and Rawson incandescent lamps of 50 candle-power. Besides the standards there are a few similar single lamps. Altogether seventy-six lamps light the hall, while in the settling room below are sixty-six lamps of 20 candle-power.

Magnetic Polarisation.—A transparent isotropic medium, placed in a magnetic field, rotates in the direction of the lines of force. Verdet has established experimentally that the rotation of the polarisation plane is proportional (1) to the intensity of the magnetic field, and (2) to the cosine of the angle made by the direction of the luminous rays with the lines of force of the field. On the other hand, M. Cornu has found the following law:—The mean of the speeds of propagation of the circular waves of inverse direction, separated by the magnetic action, is practically equal to the common speed v of these waves when the magnetic action is *nil*. From these two laws M. Cornu deduces the existence of a system of two eccentric spheres, the common axis of which is parallel with the lines of force of the magnetic field; one of the spheres corresponds with the circular waves *dextrorsum*, and the other with the circular waves *sinistrorsum*, whence he enunciates the following:—In an isotropic medium, placed in a uniform magnetic field, the two kinds of waves with circular inverse vibrations, which can alone exist, are propagated in accordance with spheres identical with the sphere of the wave of the medium in a natural condition, symmetrically displaced by the same quantity in the division of the lines of force. This magnetic displacement is proportional to the intensity of the field and to the electro-optic constant of the medium.

Electric Light in Paris.—The Paris Edison Company has put down combined arc and incandescent lighting plant, under specially favourable conditions, at the Magazins du Gagne-petit, in the Avenue de l'Opera, Paris. Though the work was only begun on 17th Nov., it was completed by the end of December. The incandescent system is naturally reserved for the rooms of moderate height, while the Cance arc lamps are employed in the larger spaces. The motive power is given by a 100-horse steam engine by Boudier, supplied with steam by two Collet boilers. All the dynamos are Edison's—two 200-lamp for the ordinary lighting, one 100-lamp for day use in the basement, and another 100-lamp machine in reserve—wise precaution. The present lighting is effected by 400 Edison and 10 Cance lamps; but 300 more lamps are shortly to be put up, and also two more dynamos. The 400 Edison lamps already fitted take the place of an equal number of 15-candle oil lamps, as the managers of the drapery establishment would never have the gas brought in, on account of the danger, but used colza lamps at nearly 3d. each an hour. The Edison lamps are arranged in separate circuits for illuminating respectively the ground floor, the *entresol*, and the four floors above, while another circuit includes the day lamps, and still another those on the staircase approached from the Rue des Pyramides. The arrangements for distributing the current are similar to those generally adopted by the Edison Company. The Cance lamps, put up by the Edison Company's engineers, and all in shunt circuit, are distributed as follows:—Four in the Avenue de l'Opera entrance, two in the dome above, and two in each of the side courts, one lamp being placed above another for simultaneously lighting the ground floor and the *entresol*.

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ABUSE OF THE TELEGRAPH.—From communications we have received on the subject of our last week's note under this heading, it appears that we have been misunderstood. Of the general utility of the "tape system" we have no doubt whatever, and our loose reference to "a dozen different offices" where Stock Exchange prices are communicated by means of this ingenious automaton did not apply in the least to those places of business where the information was received as news and for legitimate purposes. The subject is being warmly discussed in the City articles of our contemporaries in the interests of the investing public. A correspondent in the *Financial News* of the 2nd January says, "This tape matter is not what it professes; it is a maglignant attack upon outside brokers in general, and the Exchange Telegraph Company in particular; it is as foolish in policy as it is treacherous in motive. Foolish in policy as regards the dealer, because, although some of the business outside is 'set off' and cleared outside, the bulk necessarily finds its way inside." And another correspondent says, "I believe that it was in 1872 that the Exchange Telegraph Company was started to give facilities to the public, in order that they might ascertain for themselves from an independent source the current prices of the moment. The company appear to have done that conscientiously throughout. The tape has acted as a safeguard upon the broker with his client, and it has had the same effect between the broker and the jobber, and that the investing public have been satisfied with it is undoubted." It has been put to us that the one real grievance of the Stock Exchange is that outsiders get information of all their dealings; but this is obviously to the benefit of the public, because previous to the introduction of the tape brokers and jobbers could make their own prices inside, while the official list did not show the current transactions during the day, but only the closing prices which any broker or jobber chose to put upon the Board. The tape, on the other hand, is an accurate record of the transactions going on all day, and therefore the public can see whether the prices at which their stocks were bought or sold correspond with the prices ruling during the day. Something might be done possibly to diminish the gambling in outside exchanges, but it is certain that if the Exchange Company had to give up supplying prices to outsiders, it would fall into other, probably worse, hands, and be done in a more reckless fashion.

THE "RIGHT O' WAY" FOR TELEPHONES.—Englishmen profess to live under the purest form of Republicanism, their Government being practically Liberal, yet in 999 out of every 1,000 of the people no firmer conservators are to be found in the world. Englishmen detest change, come it in what shape it may, whilst our cousins in America eagerly adopt any new scheme that offers that has a tendency to make the wheels of everyday life run more smoothly. The staid Teuton is really more progressive than the Anglo-Saxon, and our neighbours of France take more earnest interest in scientific inventions and improvements than do our own countrymen. Let us take, for instance, the telephone It is universally admitted to be the most wondrous invention of the age, adapted to all and every detail of private and commercial life; yet how bitter is the cry against the companies who are endeavouring to bring it into practical use!—the cry against overhead wires as being dangerous, unsightly, &c., blocking out the pure air (!) of our great thoroughfares, disfiguring our mansions, villas, &c., and so on. Yet the growlers admit that telephony will supersede the telegraph in the not distant future. The public little know the difficulties that the officers of the telephone companies to whom is entrusted the duty of obtaining the "right o' way" have to contend with. These gentlemen must possess a general versatility of character, with the courage of a bulldog, the suavity of a collector for missionary purposes, the meekness of the dove, a glib tongue, like unto that of a Dublin car driver, a good temper, and the stoicism of a police magistrate, able to keep a smiling face under insult, and be ready to enter into conversation on the general topics of the day. You would be perfectly astounded when told how heavily the companies were handicapped by the general public in their efforts to obtain leave to run over property. For instance, one of these "right o' way" officers had successfully run a distance, and only required one "consent" to complete the line from point to point. He had managed to win over the occupier of the house to his views, and the usual agreement was about to be signed, when suddenly the parlour door was thrown open, and a shrill female voice squealed out, "Don't 'ee do onything o' the kind, Garge, for we'll git up soom marnin' an' fend oorseles deed, an' the roof on the top o' us!" That line is still incomplete, for there was only one way to do so, and that way was *Whartonised* as above. The following replies received are of daily occurrence by "right o' way" officers to their request for permission to pass over or to attach fixtures to houses, &c.:—

"I disapprove of the system of overhead wires."

"I will not allow anything of the kind."

"Declines to allow any fixture."

"Sorry to say, for various reasons, cannot sanction any such arrangement."

"Most decidedly objects."

"Both myself and landlord have a great objection to overhead wires, and must therefore refuse."

"Would willingly permit the fixture being made, but was informed by a friend that the language used by the speakers was so foul that she was compelled to remove her children's bed room to a lower room until the fixture was removed."

"I won't do anything of the kind. Why, I was a settin' with a friend as keeps a pub in the east end—oon night, at harf-past twelve, it wor on a Sunday, too, when in busts his three kids, a'most a frightened to death, and says they couldn't get a wink o' sleep becos your dratted wires were carrying a lot o' blagard langwidge backards an' forrards."

"Would rather you placed it on some neighbour's house!"

"Most decidedly not."

"I distinctly decline to permit anything of the kind!"

"Tell him I refuse and don't want to see him."

"Being an invalid is compelled to refuse."

"Tenant willing, landlord refuses."

"Landlord willing, tenant refuses."

"Has a serious objection."

"Wife has a great terror of lightning."

"Wife is very nervous."

"I absolutely refuse."

"Will not allow anything of the kind."

This is honest—"Roof too old and dangerous, otherwise consent would be willingly given."

"Thinks he has not the power, but if he had he would not sanction proposed arrangement."

"Not for £500 per annum."

A merchant asked, "How is it that telephony makes so little progress in London?" and was rather staggered on being informed, "That he himself had given a practical reply by his refusal to allow an attachment being made to his residence," and was told that if every one did as he had done—thrown cold water on the request made for right o' way—telephonic progress would of a necessity make little headway.—"*A Practical Worker*," *in the Edinburgh Courant.*

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ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

On the Transmission of Energy through Wires by the Electric Current.

Consider the electric current, how it flows. From London to Manchester, Edinburgh, Glasgow, and hundreds of other places, day and night, are sent with great velocity, in rapid succession, backwards and forwards, electric currents, to effect mechanical motions at a distance, and thus serve the material interests of man.

By the way, is there such a thing as an electric current? Not that it is intended to cast any doubt upon the existence of a phenomenon so called; but is it a current—that is, something moving through a wire? Now, although nothing but very careful inculcation at a tender age, continued unremittingly up to maturity, of the doctrine of the materiality of electricity, and its motion from place to place, would have made me believe it, still, there is so much in electric phenomena to support the idea of electricity being a distinct entity, and the force of habit is so great, that it is not easy to get rid of the idea when once it has been formed. In the historical development of the science, static phenomena came first. In them the apparent individuality of electricity in the form of charges upon conductors is most distinctly indicated. The fluids may be childish notions, appropriate to the infancy of science, but still electric charges are easily imaginable to be quantities of a something, though not matter, which can be carried about from place to place. In the most natural manner possible, when dynamic electricity came under investigation, the static ideas were transferred to the electric current, which became the actual motion of electricity through a wire. This has reached its fullest development in the hands of the German philosophers, from Weber to Clausius, resulting in ingenious explanations of electric phenomena based upon forces acting at a distance between moving or fixed individual elements of electricity. It so happened that my first acquaintance with electricity was with the dynamic phenomena, and after I had read with absorbed interest that instructive book, Tyndall's "Heat as a Mode of Motion." This may explain why, when it came later to book learning regarding electricity, I had the greatest possible repugnance to all the explanations, and could not accept the electric current to be the motion of electricity (static) through a wire, but thought it something quite different. I simply did not believe, except so far as mere statements of experimental facts were concerned. This had its disadvantages; one can get on faster if one has sufficient faith—which we know moves mountains—to accept a certain hypothesis unhesitatingly as a fact, and work out its consequences undoubtingly, regardless of the danger of fixing one's ideas prematurely.

As Maxwell remarked, we know nothing about the velocity of electricity; it may be an inch in a year or a million miles in a second. Following this up, it may be nothing at all. In fact, it is only on the hypothesis that the electric current is something moving, a definite quantity in a given space, that we can entertain the idea of its possessing velocity. Then, the product of its hypothetical density into its velocity is the measure of the current; but, being a mere hypothesis, unless we choose to accept it, to talk of the velocity of electricity in the electric current becomes meaningless. On the other hand, when we apply the ideas of abstract dynamics to electricity, and compare the electric current to a velocity, it is not the above suppositious velocity of electricity that is referred to in any way. It has no meaning. It is the supposed velocity of electricity in the electric current; whereas, in the dynamical theory, it is the electric current itself that is a velocity, in the generalised sense, with electromotive force as the generalised force; so that force × velocity = activity. In only one sense do I think we can speak of the velocity of electricity, consistent with Maxwell's theory, viz., by the hypothesis that the electric current in a wire is the continuous discharge of contiguous charged molecules, when plainly we can call the velocity of motion of a molecule the velocity of the charge it carries. As between the molecules we have the electric medium the ether, this view of the conduction current ultimately resolves itself into "displacement" currents in a dielectric.

But is there not the fact that we can send a current into a long circuit, and that it plainly travels along the wire, taking some time to arrive at the other end? Does that not show that electricity travels through the wire? To this I should have answered formerly, when filled with "Heat as a Mode of Motion," is it not a fact that there is a transformation of energy in the battery, and that this energy is transmitted through the wire, there suffering another transformation, viz., into heat; that when the current is set up steadily, the heat is generated uniformly; that the electric current in the wire is therefore some kind of stationary motion of the particles of the wires, not exactly like heat, but having some peculiarity of a directive nature making the difference between a positive and a negative current; but that there was no evidence in the closed circuit of any motion of electricity through the wire, but only of a transfer of energy through the wire.

However, leaving personal details of no importance to anyone but myself, let us consider the transmission of energy through a wire. How is it done? Knock and it shall be opened unto you? No, not exactly; but we may get a peep through the door "on the chain."

To fix ideas, let our circuit be an insulated suspended wire from London to Edinburgh, and that we transmit energy to Edinburgh from a battery in London, the circuit being completed through the earth. Let the current be kept on. In the first place the phenomenon is steady. It does not change with the time. Next we find that the magnetic force about the wire is the same everywhere at the same distance, or the wire is in the same condition as regards the magnetic induction outside it, and when we apply our knowledge to the interior of the wire regarded as a bundle of smaller wires, we find that the magnetic force *in* the wire does not vary along its length. Again, heat is being generated within the wire at a uniform rate (a part of the steadiness above mentioned), and, next, this phenomenon is also the same all along the wire. Heat is undoubtedly a kinetic phenomenon, hence the electric current is also, at least in part, a kinetic phenomenon. The electric current is not itself heat; but as its existence in the wire involves the continued production of heat, we conclude that some kind of motion is necessarily involved in the electric current apart from the heat produced, and from the uniformity of effect in different parts of the wire, that it is a kind of stationary motion. Again, the electric force is the same all through the wire. There seems no difference between one part and another. Outside the wire, in the dielectric, however, there is a difference, for the electric force varies not only at different distances from the wire but also at the same distance outside different parts of the wire. (We disregard here all irregularities due to other conductors and currents.)

Passing to the battery, the complexity of conditions makes it more difficult to follow, though the state of electric force and magnetic force and heat generation is reducible to the same, and may be made identically the same as in the wire by properly choosing its shape, &c. But in the battery there is a very remarkable thing taking place, namely the loss of chemical energy at a steady rate, and in the system generally, a still more remarkable thing, an exactly equivalent steady gain of heat. Heat that might have been produced on the spot by the chemical action otherwise conducted appears all over the circuit. How does it get there? The natural answer is through the wire. But to get to the further parts of the wire it must go through the nearer, hence there must be what we may call an energy current, which, in the wire, at a given place, would be the rate of transfer of energy through a cross section there. Now, which way is the energy current directed? It would seem only fair to let it go both ways equally from the battery; Let it be so, first. Then there is an energy current entering the wire equal to one-half the dissipativity, which falls in strength regularly up to the middle of the wire, where it is zero. It falls in strength on account of the heat generation.

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Similarly the other energy current goes through the earth to Edinburgh almost unabated in strength, and is then directed from Edinburgh to the middle of the wire, where its strength also falls to nothing. This seems absurd. Then let the energy current be directed one way only, say with the positive current. If the positive pole of the battery is to line, we have an energy current in one direction all round the circuit, London to Edinburgh, and back through earth. If of maximum strength at the battery it falls nearly to nothing at the distant end, and quite to nothing through the earth up to the other pole of the battery. But we have no data whatever to fix whereabouts the place of maximum energy current is. It requires a second assumption. The reader may similarly consider the effect of reversing the battery, or of making the energy current be directed with the negative current. There is no getting at anything definite, except that the energy current must vary very widely though regularly in strength, whilst there is nothing to fix which way it is directed or where the maximum strength is. Again, the energy current is a kinetic phenomenon, and as it varies so enormously in different parts, we might expect different parts of the wire itself to be in different electrical states, which is exactly what we do not do, for though its potential varies, yet potential is not a physical state, but a mere scientific concept.

Had we not better give up the idea that energy is transmitted through the wire altogether? That is the plain course. The energy from the battery neither goes through the wire one way nor the other. Nor is it standing still. The transmission takes place entirely through the dielectric. What then is the wire? It is the sink into which the energy is poured from the dielectric and there wasted, passing from the electrical system altogether. All difficulties now disappear.

That the energy of the battery passes into heat immediately would require its instantaneous transmission to all parts of the wire, which cannot be entertained. There must be an intermediate state or states, after leaving the battery and before becoming heat. And there must be a definite amount of energy in transit at a given moment; in the steady state this must be of constant amount, just as the total rate of transmission is of constant amount. We must not, however, individualise particular elements of energy, and follow their motions, but regard the matter quantitatively only. The energy in transit may be compared to the energy of a machine which is transmitting motion; if done at a steady rate, it remains constant and definite, and the rate of transmission is definite.

Now in Maxwell's theory there is the potential energy of the displacement produced in the dielectric parts by the electric force, and there is the kinetic or magnetic energy of the magnetic induction due to the magnetic force in all parts of the field including the conducting parts. They are supposed to be set up by the current in the wire. We reverse this, the current in the wire is set up by the energy transmitted through the medium around it. The sum of the electric and magnetic energies is the energy of the electric machinery which is transmitting energy from the battery to the wire. It is definite in amount, and the rate of transmission of energy (total) is also definite in amount.

It becomes important to find the paths along which the energy is being transmitted. First define the energy current at a point to be the amount of energy transferred in unit time across unit area perpendicular to the direction of transmission. As the present section is argumentative and descriptive only, we cannot enter into mathematical details further than to say that if H be the vector magnetic force and E the vector electric force, not counting impressed forces, the energy current as above defined is $VEH/4\pi$ (see equation (3) for definition of V.) This is true universally, irrespective of the nature of the medium as to conductivity, capacity, and permeability, or as to eolotropy or isotropy, and true in transient as well as in steady states. A line of energy current is perpendicular to the electric and the magnetic force, and is a line of pressure. We here give a few general notions.

Return to our wire from London to Edinburgh with a steady current from the battery in London. The energy is poured out of the battery *sideways* into the dielectric at a steady rate. Divide into tubes bounded by lines of energy current. They pursue in general closed paths in the dielectric and terminate in the conductor. The amount of energy entering a given length of the conductor is the same wherever that length may be situated. The lines of energy current are the intersections of the magnetic and electric equipotential surfaces. Most of the energy is transmitted parallel to the wire nearly, with a slight slant towards the wire in the direction of propagation; thus the lines of energy current meet the wire very obliquely. But some of the outer tubes go out into space to an immense distance, especially those which terminate on the further end of the wire. Others pass between the wire and the earth, but none in the earth itself from London to Edinburgh or *vice versâ*, although there is a small amount of energy entering the earth straight downwards, especially at the earth "plates." If there is an instrument in circuit at Edinburgh, it is worked by energy that has travelled wholly through the dielectric, then finding its way into the instrument, where it enters the coil and is there dissipated, or else used up by the visible motions it effects in moving parts of the instrument; which, however, is a different kind of affair from dissipation, as it involves impressed force.

Now go into the line wire. A tube of energy current arriving at the surface of the wire by a long slant, at once turns round and goes straight to the axis. In passing from the battery to the wire through the dielectric the energy current is continuous, the state being steady (or the ether machinery frictionless); but directly it reaches the conducting matter of the wire dissipation commences and the current begins to fall in strength, and on reaching the axis has fallen to nothing. Not a fraction of an erg is transmitted along the wire. Some small part of the energy leaving battery may enter it again, but most of the dissipativity in the battery itself is accounted for by the weakening of strength in tubes which are on their way to leave the battery.

Put the battery in the middle of the line; earth at both ends. Now, one half of the energy current tubes leaving the battery sideways turn round to one section of the line, the other half to the other section. Otherwise the case is similar to the last.

When we have a double wire looped without earth, and battery at one end, most of the energy is transmitted between the wires.

In a circular circuit, with the battery at one end of a diameter, its other end is the neutral point; the lines of energy current are distributed symmetrically with respect to the diameter.

On closing the battery circuit there is an immediate rush of energy into the dielectric, and, at the first moment, into all bodies in the neighbourhood of the battery, and wasted there in induced currents according to their conductivity. In the variable state the tubes of energy current are themselves in motion. It takes some time to set the electric machinery going steadily. Also the energy current is not continuous in the dielectric, for the potential energy of displacement and the magnetic energy have to be supplied at every place. But in the end the energy current becomes continuous in the dielectric, goes round an external conductor instead of entering it, as it would do in the transient state, and finally reaches the conductor to which the battery is connected, penetrating which it terminates.

If we neglect the magnetic energy, as in Sir W. Thomson's original telegraph theory, against the energy of electric displacement, we can easily get a general idea of the setting up of the permanent state in a long suspended wire; a submarine cable is more complex on account of the sheath. The energy reaches the beginning of the wire first, and only reaches the end, save insignificantly, later on. But the theory indicates instantaneous setting up of current at the far end, though not in recognisable amount. This result follows from the neglect of the magnetic energy. In a dielectric medium the velocity of undisturbed propagation is $(c\mu)^{-\frac{1}{2}}$; c the capacity, μ the permeability; the magnetic energy $=0$ is equivalent to $\mu=0$ everywhere, whence instantaneous transmission. The "retardation," however, arises from the setting up of the potential energy of displacement. But strictly speaking, we must not

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neglect μ. It is, then, not so easy to follow the transient state without simplifications. There is an oscillatory phenomenon in the dielectric, a to and fro transmission of energy and pressure parallel to the wire all round it with a velocity whose possible maximum is that of undisturbed transmission. This is modified as it progresses by dissipativity in the wire, and so gets wiped out. This usually occurs so rapidly that the oscillations are of importance only at the battery end of a long wire. The electric machinery must have mass, as well as elasticity, by reason of this phenomenon, since there is reason to believe (Maxwell's theory of light) that it is not the air, but something between the air molecules that is the electro-magnetic medium, the air merely modifying the phenomena somewhat.

In the state of steady current through a submarine cable, with an iron sheath outside the dielectric, the energy is transmitted wholly through the gutta percha or other suitable insulator (neglecting the small amount going to earth), thus nearly parallel to the wire, practically quite parallel, except as regards the lines near the wire itself, as they all eventually meet the wire. No transmission in the sheath, though there is dissipativity there if it should contain, as it does sometimes, part of the return current. In the transient state there is of course always dissipation in the sheath more or less, besides the loss of energy to magnetise it.

Now to speak more generally. In the steady state of current due to any impressed forces, the tubes of energy current start sideways from the places of impressed force, where energy is supplied to the electric system, and travel through definite paths, without loss in dielectric, with loss in conducting parts, to terminate finally in conducting matter; or else they may go from one place of impressed force to another with or without dissipation on the way when the current is with the impressed force at one source, and against it at the other. But with special arrangements (solenoidal) of impressed force, there is no transmission of energy in the steady state.

Since on starting a current the energy reaches the wire from the medium without, it may be expected that the electric current in the wire is first set up in the outer part, and takes time to penetrate to the middle. This I have verified by investigating some special cases.

Increase the conductivity of a wire enormously, still keeping it finite, however. Let it, for instance, take minutes to set up current at the axis. Thus ordinary rapid signalling "through the wire" would be accompanied by a surface current only, penetrating to but a small depth. The disturbance is then propagated parallel to the wire in the manner of waves, with reflection at the end, and hardly any tailing off. With infinite conductivity there can be no current set up in the wire at all. There is no dissipativity; wave propagation in the medium is perfect. The wire current is wholly superficial, an abstraction, yet it is nearly the same with very high conductivity. This illustrates the impenetrability of a perfect conductor to magnetic induction (and similarly to electric current), applied by Maxwell to the molecular theory of magnetism. Whatever state of magnetic induction and of current there may be in a perfect conductor is a fixture. If we move the conductor about in a magnetic field, superficial currents are instantaneously induced, whose only function is to ward off external induction and keep the interior state unchanged.

In a thermo-electric circuit of two metals with one junction a little hotter than the other, there is a transmission of energy from one junction to the other through the dielectric, with a trifling amount of loss in the circuit generally. Here the source of the electric energy is heat, and the final result is heat. One junction is cooled, the other is heated, reversibly. Now, heat is the energy of molecular agitation, and at first sight the only difference is that the agitation is a little more brisk at one junction than at the other. Again, all parts of the circuit are agitating the ether. It would appear, then, that the ordinary molecular agitations set up no electric manifestations on account of their irregularity; although the electric machinery may be influenced vigorously, yet it must be done in some regularly symmetrical manner to constitute an impressed electric force. At the junctions there is a change of material, the molecules are different, and at their contact some directed quality is given to the agitations. This is very vague, no doubt, but is merely to point out that the impressed force is a symmetrical kind of radiation.

After these general remarks the temporarily interrupted mathematical treatment will be resumed.

(TO BE CONTINUED.)

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

The first of a course of six lectures adapted to a juvenile auditory by Professor Tyndall, on "The Sources of Electricity," was delivered, on Dec. 27, at the Royal Institution, Albemarle-street, Piccadilly.

Professor TYNDALL, in opening the course, said he knew that the delivery of such lectures caused pleasure to others besides himself. It was a pleasure to his colleague, Professor Dewar, and to their noble and good master, the late Professor Faraday, who in the later years of his life lectured to no one else but to those whom he loved to call the juveniles. Nine years ago he (Professor Tyndall) undertook to lecture upon the subject of electricity to boys and girls in that institution. At that time he took what he now called friction electricity, and he devoted the whole of the six lectures to that subject. His intention now was to give them a connected story, so to say, from beginning to end—commencing with the smallest germ, and showing them how it grew up until it had reached the development of the present time. Many of them were aware that the name of this electricity was derived from the fact that first facts were observed by the ancients in the attraction of light bodies by amber. Amber was called, as many of them knew, electron—hence the name electricity, that was, that wondrous power of attraction which amber at first exhibited. It might be mentioned that amber was still found in various parts of the earth. It was found in Europe, especially on the shores of the Baltic, particularly after storms, when it was cast upon the waves, and gathered there. There were also beds of fossil trees. In point of fact, along the shores of the Baltic the amber tree in distant times bloomed; and just as the poplar at the present time oozed out its gum, or the pine tree its resin, so the amber tree in those days dropped its precious gum into the sea; and where the amber had fallen and could be converted into lignite, they there found the amber diffused among the fossil amber trees. The ancients had another story about amber. They considered it a very costly ornament, and paid dearly for it; and, indeed, at the present time, the revenue derived from the sale of amber is very considerable. The ancients told them that the daughters of the sun, for some reason, were converted into poplars, that these poplars wept tears at their sufferings, and that these tears, petrified, became amber. They would find the account in Sir George Cornewall Lewis's History of Ancient Astronomy. He would begin with the first experiment made with amber. He held in his hand a piece of amber made into the form of a stick consisting of the two mouthpieces of pipes fused together. By means of this stick he would show them the attraction of light bodies by amber. Rubbing the amber with catskin, he showed how some bran was attracted by the amber. [Experiment.] The human mind was never contented with merely looking at a thing and seeing that thing occur; they were never contented with facts. Therefore, at an early time, the question occurred, Why did amber attract light bodies? The ancient philosopher was following the irresistible profundity of the human mind when he asked the reason of this. He supposed the amber to possess a soul, and in virtue of this soul attracted these light bodies. This was the theory of the celebrated Newton, the great astronomer and philosopher. There were various other ways of showing this attraction. For instance. [Experiment.] He placed a lath upon a point, and showed how a glass tube, after being rubbed, as he had rubbed the amber, acted upon the lath. He ought, however, first to have stated that this attraction of light bodies by amber was the only thing known to the human mind for 2,000 years. Not until the year 1600 was the bond pierced by the celebrated Dr. Gilbert in the time of Queen Elizabeth. Dr. Gilbert said, "If you look at amber it is a kind of gum. You see insects sometimes entangled in it. It would be very extraordinary if this were the only thing capable of attracting light bodies." Dr. Gilbert therefore set to work, and found a vast number of other substances attracting light bodies, like glass, for instance, in its action on the lath in the experiment he had shown. They might use sealing-wax instead of the glass tube he had used. The lecturer then, to illustrate this, showed several other experiments with a watch glass, an egg, a piece of sealing-wax, and a small wheel. He wanted to impress on them the quality of what was called a scientific mind. It had the quality of looking behind facts. They would observe in the experiment that

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the wheel followed the glass tube about as a carriage followed the horses harnessed to it. The question which a scientific mind asked was, "Is there anything between the glass tube and the wheel?" That was a question which occupied the mind of the great Sir Isaac Newton as to gravitation. He asked himself, "How is it that the sun can control the earth in its orbit. He was too cautious to express any definite opinion on the matter, but his conclusion was that there was something there which enabled the sun to act upon the earth. In the same way he (the lecturer) now asked them this question—whether anything existed between that wheel and the glass tube? That question was one of the most important that occupied the minds of scientific men. They wanted to know whether there was a medium between that glass tube and that wheel. It was, as he had said, a point which was occupying the minds of scientific men, and perhaps they would not solve it in our day. Another experiment was made with regard to attraction by Sir Isaac Newton, who was a great experimenter as well as a great mathematician, and he was very much taken by this electrical attraction. He made this experiment: He wore a dressing gown; he got a plate of glass and placed light bodies, such as bran, over that plate of glass, on which rested a ring of brass, placing over it a plate rubbed against his dressing gown. Projecting the shadow of the brass upon the screen, the lecturer showed this experiment, and how the bran was acted upon. Incidentally he drew attention to the arrangements he had provided for keeping out of the theatre all vapour and moisture, the arrangements being, he observed, to secure dryness, and not warmth or heat. Passing on to the laws of this attraction which they had just seen, he said he would give them an experiment which was first made by a sturdy old fellow, the burgomaster of Magdeburg, in Prussia, Otto Guericke, who invented the air pump. He noticed that when one brought an electrified body to and near a suspended feather one saw it attracted there. He noticed after it was attracted, and after it touched the attracted body, that it was repelled. [This experiment the lecturer then showed, using the glass tube before mentioned.] He might, he explained, use sealing-wax, or shellac, or a variety of other bodies. Showing how the feather was drawn towards a stick of gutta percha and driven away by a glass tube, he stated that in this exhibition they had the first notion of the difference between electricity on the surface of the glass and upon the surface of gutta percha. The one attracted, the other repelled the feather. He would now show them an experiment which he himself first made that morning, guided, of course, by the principles of electricity. They had seen him, he first observed, communicate the electricity upon the surface of the glass tube to the feather, and that when the feather had upon it the same electricity as the glass tube, the feather was repelled. Taking a stand and resting it upon the table, he remarked that he wanted something to interpose between the stand and the table which would not allow the electricity to pass from the lath placed upon it to the table. He found this something in a piece of shellac, but he might use common resin, or sealing-wax, or india rubber. He would, however, use the shellac, and he now knew that any electricity he might communicate to the lath would be prevented from going to the earth. He was forestalling matters a little, but in a few moments they would understand all he was saying. The experiment would be attended with some risk, as when he first made it that morning he wore a different coat, and he did not know whether the coat he was wearing at that time would behave as the coat he wore in the morning did. He then requested his assistant (Mr. Cotterill) to strike him with the catskin, thus electrifying him. At the same time he drew his hand over the lath, explaining that in that way he was communicating to the lath the same electricity which Mr. Cotterill was exciting upon his body. They would observe how the lath followed his hand—a movement he afterwards stopped, observing in continuation that he had communicated to the feather the electricity upon the glass, this self-same electricity proving itself repulsive. In the same way in the experiment he had just given, the electricity communicated to his hand had caused his hand to repel the lath. He would ask them to go fully into this matter with him, because it underlay the whole of electrical science. Sir Isaac Newton found his dressing gown was better for his glass than other substances. It was soon found that the electricity excited depended a good deal upon the rubber—a towel would not excite the same electricity as a catskin. Taking two sticks of sealing wax and balancing one on the cradle he rubbed the second stick and showed the attraction and afterwards the repulsion of the two substances electrified in the same way. He subsequently repeated the experiment with two pieces of gutta percha, and said he might go on with sulphur and sulphur, two paraffin candles, or paraffin and wax, or he might take ebonite and ebonite. Taking an ebonite comb he passed it through his hair, and then showed how it repelled another ebonite comb, which was balancing in the cradle. Sealing wax was a common substance, and might be taken as representative of the whole class of the so-called resinous bodies. Taking a stick of gutta percha, however, he proceeded to show the effect on it of a vitreous body. [Experiment shown.] Instead of repulsion they saw powerful attraction. He might go through the whole of these bodies, and in each case show that a resinous body repelled a resinous body and a vitreous body repelled a vitreous body. Suspending a glass tube, and exciting it by rubbing it, he took another glass tube, and having rubbed it demonstrated the repulsion of the one from the other. Having repeated the experiment with two sticks of sealing wax, he placed the glass tube in the balance, and showed the attraction between it and a resinous body—a piece of the sealing wax. He wished them to bear in mind that they were here at the fundamental law of electricity—like electricities repelled each other, unlike electricities attracted each other. The terms "vitreous" and "resinous" electricities were at the present time abandoned, and the electricity developed by glass they called positive electricity, the electricity developed by sealing wax and the resinous bodies being called negative electricity. There was, however, no reason whatever why one should be called positive and the other negative; it was simply done by agreement among scientific men, in order that they might understand each other when they talked of positive and negative. He next showed two pieces of ribbon electrified alike "standing at utter enmity to each other;" and afterwards placed a sheet of paper on a wooden board. There was not, he said, the least attraction between the two, but having passed a stick of india rubber over the paper, he showed that he required to use some force to get the paper away from the board. With two slips of paper he next illustrated the law that similar electricities caused repulsion. Several strips of paper suspended and insulated were then brought forward by the lecturer's assistant, and the former rubbed a glass tube and held it towards the strips, which at once commenced to diverge from each other—entirely owing, the lecturer observed, to the repulsion of the same kind of electricity. Calling attention next to the electroscope, he cast its shadow on the screen behind him, showing two pieces of gold leaf suspended. He then placed two balls, separated, on stands, took an arch of thick copper wire, and made the distance between the two balls sufficient to enable him to span them with the arch. Neither ball, he explained, had any power of attraction at present, but having communicated electricity to one of them by means of a glass tube, he spanned the two with the arch of copper wire, and showed how the electricity from the one was thus communicated to the other ball. This had been done by what was called a flow of electricity, and hence the notion of an electric current. To illustrate this principle still further, he attached a piece of copper wire to the arch, connecting it with the electroscope; and having touched one of the balls with the arch, he showed how a portion of the electricity thus communicated to the ball went through the wire to the electroscope, making the pieces of gold leaf diverge considerably. By means of a further experiment he caused the gold leaf again to collapse, and resume its former position. Detaching the piece of copper wire from the arch, he replaced it by a piece of dried twine, and having electrified the ball as before, showed that the twine had no power to conduct the electricity—a power, however, which he afterwards showed was possessed by ordinary undried twine. He wished to impress on their minds in a manner never to be forgotten the influence of moisture. The dried twine was rendered an insulator; the ordinary twine was a conductor. He repeated this experiment with a piece of silk, first in a dry and afterwards in a wet or damp state, and showed that in its former condition it was an insulator, while in its moist state it conducted the electricity. In the early part of his lecture he had spoken of the tendency of the human mind to inquire into the hidden causes of things; and as to these phenomena, those hidden causes were entirely beyond the range of sense. They must be seen by the scientific intellect. He wished to give them an idea of a notion long entertained by scientific men regarding electricity. There were two kinds, they said, positive and negative; and they further said that these positive and negative electricities were mixed together in all bodies. He must now come to what he called a very beautiful experiment, which occurred to him two days previously. [Experiment shown on the screen.] In front of the lamp they had a brass ball suspended and connected by wire with a cylinder of brass. Mr. Cotterill would place upon that some loose bran, and then they would see what would occur. He would excite his glass tube, which he then passed over the cylinder. This glass tube would attract the negative electricity, and the other electricity, the positive, would flow towards the brass ball, and if it reached the ball and electrified it the bran underneath ought to jump up to it. In this experiment he had not touched the cylinder with the glass tube. Supposing, however, he touched the cylinder before he brought the glass tube to bear upon it, they would see that there was no jumping of the bran. Why? Because the positive electricity, instead of going to the bran, had flowed through his body to the earth. The moment he removed his hand the liberated positive flowed towards the bran, which they saw jumping again. With this experiment the first lecture of the course was concluded.

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THE ELECTRICIAN.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

ANSWER TO CORRESPONDENT.

TROUVÉ'S PORTABLE LAMPS.—*In reply to inquiries as to where the Trouvé lamps and batteries may be obtained, Capt. Aylmer, M.P., who showed these lamps at the Hammond College Conversazione, has secured the English and Colonial patent rights. The inventor's address is Rue Vivienne, Paris.*

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1884.

(CONTINUED FROM PAGE 164.)

TELEGRAPHY.—We now turn to the most important application of electricity—telegraphy. By its means space is practically annihilated, and so general is this application becoming that ere long conversation telegraphically between friends breakfasting fifty miles apart may not only be possible but common. It will be seen that we agree with the legal decision that telephony is only a phase of telegraphy. By means of the latter, communication is almost instantaneous between points thousands of miles apart; by the former the crying of the baby in London can be heard by the anxious parents at Brighton. The mind almost fails to grasp the gigantic strides that have been made during the past half century in these applications of electricity. While many arts have degenerated—witness the rudeness and crudeness of our architecture, our painting, our glass staining, &c.—civilisation has progressed in the art of intercommunication. Before directing attention to the telegraphic and telephonic work in England during the past year, we may be allowed to refer generally to the position of the telegraphs in 1880-1—the latest date down to which we have complete official records. The American Government collected statistics to that date, issued with the American census report, containing a mass of interesting information, the like of which is not to be obtained elsewhere—at any rate, outside of official pigeon-holes.

GREAT BRITAIN.—On March 31, 1881, there were 4,015 post offices and 1,423 railway stations open for telegraph work, making the total number of telegraph offices within the United Kingdom 5,438, as compared with 2,488 under the telegraph companies. The date of transfer from companies to the Government was January 29, 1870, so that in the course of eleven years the number of offices had been more than doubled. On taking over the telegraphs the Post Office commenced with 5,651 miles of telegraph, with 48,999 miles of wire. At the date above mentioned these numbers had increased to 26,319 miles of line, with 121,052 miles of wire. The number of words delivered during the year ending March 31st, 1881, was 327,707,407, while the work done for the Government itself was valued at £19,479. The number of the telegraphists employed by the companies was 2,514, of whom 479 were women, the number of messengers 1,471, while the Government had respectively 5,611; of these 1,536 were women, and 4,648 messengers. These latter numbers are exclusive of those persons indirectly employed, such as those paid by postmasters out of allowances for assistants.

GERMANY.—Telegraphy has here from its beginning been a State institution. The rates for ordinary telegrams are:—(1) An initial charge of 0·20 mark for every telegram; (2) within the empire a charge of 0·05 mark per word; (3) for city, *i.e.*, local telegrams a charge of 0·02 mark per word. For urgent telegrams, to which precedence is given, a threefold charge is made. For press telegrams in the daytime the charge is 20 or 40 marks per hour, according as the Morse or the Hughes instrument is used; at night the rate is but half this amount. The value of Government messages in 1880 was about 100,000 marks.

FRANCE.—Here also the telegraph is a State institution. The tariff is 5 centimes per word, with a minimum of 50 centimes. The press messages are at the rate of 24 francs per hour for the use of a wire erected with the assistance of the paper, otherwise 50 francs per hour. In Paris the normal tariff is reduced 70 per cent. for messages despatched either by pneumatic tubes or on the newspaper's own wires. The value of the press messages in 1880 was 1,722,683 francs.

AUSTRIA.—The telegraphs are State property, but certain concessions have been granted to railways, to Vienna, to companies in local capitals, to five telegraph lines, and to cable companies. The tariff is 28 kreuzer for the first two words, and 2 kreuzer for each word after. Local—*i.e.* in same town, messages half that rate. For urgent telegrams a threefold rate is charged. Press telegrams at night pay 5 florins for 500 words, and 1 florin for each additional 100 or part thereof.

HUNGARY.—The State took over the telegraphs in 1867, when there were 650 stations, 12,271 kilometres of line, and 36,311 kilometres of wire. In 1880 the respective figures were 1,083, 15,525, and 55,137. The tariff seems similar to that of Austria, 24 kreuzer for two words, and for each word after 2 kreuzer.

RUSSIA.—The State owns the telegraphs. The tariff varies with distance. The first zone embraces Russia in Europe, as far as the meridian of Ekatérimbourg, including the Caucasus; the second, Russia in Asia, as far as the meridian of Strelinsk, including Turkestan; and the third, extending from that meridian to the extreme limits of the empire. Each of these three parts is subdivided into three zones. The first measures a distance of 200 versts, the second 1,000 versts, and the third comprises all the space beyond the second. The tax is based on a minimum of ten words; for this minimum the charge is 30 copecks in the first zone, 60 copecks in the second, and 1 rouble 20 copecks in the third. For each supplementary tax must always be increased to an even number; in the second zone, 5 copecks for each supplementary word, and in the third 10 copecks. For the

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transmission of telegrams from one of the three parts of Russia to one of the others there is charged a sum made up of the charges belonging to each part. Press telegrams are subject to the ordinary charges, but special agencies, at present two in number, the International Telegraph Agency and the Agency Petersburg, Moscow, enjoy a reduction of 50 per cent. Besides these two agencies, special privileges are accorded to a daily paper at Moscow, called the *Telegraph of Moscow*. The editors of this paper have contracted for the use of a wire between St. Petersburg and Moscow every night between eleven in the evening and four in the morning. The price agreed upon was based upon the charge per word between the two capitals, which is 5 copecks.

SWITZERLAND.—The telegraphs are a State institution. In 1880 there were 6,555 kilometres of line, with 16,017 kilometres of wire. The railway lines belong to the companies, and had 328 kilometres of line, with 2,825 of wire. The total number of offices numbered 1,108; of these 932 gave a continued service, 73 were used in summer only, and 103 were railway offices. An initial charge of 30 centimes is made for internal telegrams (we have considered only internal arrangements throughout these notes), and a further charge of 2·5 centimes per word. The press receives no favour, but is charged at the ordinary rate. Official telegrams have to pay, except such as relate to the telegraph service itself.

BELGIUM.—The telegraphs belong to the State. On January 1, 1881, the complete telegraphic system comprised 823 offices accessible to the public for the transmission of telegrams, and 26,153 kilometres of wire. These lines included 22,279 kilometres of wire constructed along the railroad managed by the State, 1,883 kilometres of wire along the highways, 601 kilometres of wire along the water-courses for the use of navigation and for the announcement of the rising of the waters, 1,158 kilometres of wire attached to the poles belonging to the State by chartered railroad companies for use in their business, and 232 kilometres of underground wire. The rate of an ordinary message is 50 centimes for from one to ten words, and 10 centimes for each additional five words. Urgent telegrams are charged double, as are telegrams sent after nine o'clock at night. Belgium has no special rates for press telegrams. The *personnel* of the service comprised, on December 30th, 1880—Officers and telegraphists 1,009, workmen and messengers 1,212—a total of 2,221, besides whom are 2,162 railroad and postal agents who assist.

THE NETHERLANDS.—The system belongs partly to the Government and partly to private companies. In December, 1880, there were 396 offices, 191 conducted by the Government and 205 by individuals. A telegram of minimum length is charged 15c., for every other word 1c. is charged. No special tariff for the press.

SWEDEN.—The system is under the Government, except certain private railway lines, which are under partial control. The number of offices in Sweden at the close of 1880 was 784, of which 176 belonged to the State, 187 to the State railways, and 421 to private railways. The length of lines belonging to the State is 8,288 kilometres and 20,336 length of wire; to the State railways 516 kilometres of line and 5,406 of wire; to private railways 2,716 kilometres of line, and 3,698 of wire. In most of the telegraph districts the State and the State railway telegraphs use the same poles. The tariff is 1 kronor for 20 words or less, and 25 öre for each succeeding 5 words, with a delivery charge of 10 öre. The press is not favoured.

NORWAY.—The State owns all the telegraph lines in the country, and was the original owner of the same. The length of telegraph lines is 5,313 English miles, of which 4,634 miles belong directly to the State and 681 miles to the railways, which are owned and controlled by the State. The total length of wire is 9,726 English miles, of which 8,414 belong directly to the State and 1,312 miles to the State railways. A simple telegram of 15 words is charged 1 kronor, with a charge of 20 öre for each succeeding 3 words. The press messages are sent at a less rate for the additional words.

DENMARK.—The State owns the system, except the lines along private railroads, and one line with a special concession. At the end of 1880 the State had 128 stations, with 476·22 geographical miles of line, and 1,261·10 miles of wire, in addition to 159 stations on the Government railroads. The rate is 50 öre for 20 words, and 25 öre for each additional 10 words, or less. Press telegrams pay as ordinary, except in one case, in which a newspaper pays by the hour.

PORTUGAL.—The system belongs to the State, which had in 1880 some 930 stations and 5,329 miles of wire.

ROUMANIA.—The system belongs to the State, which had in 1880 some 102 stations, with 5,145 miles of wire. Tariff, 8 centimes per word, except for local messages, which are charged 5 centimes per word. The press rate is the same. The value of Government messages in 1880 was 97,884dols.

TURKEY.—The Government owns the system, with, in 1880, 471 offices and 45,072 kilometres of wire. The tariff varies with distance, being 9 cents for immediate district around capital and amounting to 1·98dol. for messages of 20 words to the Asiatic provinces. There is no special press rate.

POST OFFICE TELEGRAPHS.—The prevailing depression of trade has, as was to be expected, seriously affected the revenue from telegraphic traffic during the past year, the first three quarters of the financial year showing a deficiency of £5,000 against the increase of £53,000 estimated by the Chancellor of the Exchequer last April. It would appear, therefore, that the reduced tariff promised for the present year will not be inaugurated under very encouraging conditions. The reduction, however, having been definitely determined upon, extensions in anticipation of the certain augmentation of traffic have been proceeded with on a large scale. It is wisely considered that the only way to make the new tariff remunerative is to provide ample acccommodation for its transmission, so as to encourage the multiplication of cheap short messages, and this whatever may be the basis of the tariff finally adopted. A decision has not yet been come to on this critical question; but so far as the engineering preparations are concerned, there seems to be no cause for doubt as to the sufficiency of the preparations made to meet any increase of work likely to accrue for some time to come.

The additional great trunk line which had been partially advanced prior to 1884, but completed only between Glasgow and Carlisle, is now nearly finished, so that in a short time a system comprising from seven to seventeen wires will connect the metropolis with Scotland, including on its way the great commercial centres of the western counties. A similar system of equal magnitude, that is to say comprising an average of ten wires throughout, has been erected along the east coast connecting London with Newcastle and the intermediate important towns. Both these new lines have been carried along the high roads and are quite independent of the railways.

Besides these two great schemes additional circuits have been given to the following places:—Newcastle, Liverpool, Manchester, Leeds, Hull, Nottingham, Sheffield, Birmingham, Cardiff, Bristol, Portsmouth, Southampton, Margate, Ramsgate, and Dover. These new circuits are duplexed—duplex

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working, indeed, being now the rule on every new wire. To provide for what may be called the increased local traffic of populous areas the circuits radiating from the chief towns have been extended and improved. Aberdeen, Glasgow, Edinburgh, Inverness, Newcastle, Liverpool, Manchester, Hull, Leeds, Chester, Shrewsbury, Birmingham, Bristol, Gloucester, Exeter, Plymouth, Southampton, Portsmouth, Belfast, Dublin, Limerick, Cork, are among the places so dealt with. The metropolis, of course, has received special attention in these respects, having had its capabilities enlarged both by additional wires and by improved apparatus. An additional cable of four wires has been laid to Jersey by the Post Office's new telegraph cable ship "Monarch," which has also laid a six-wire cable between Lowestoft and Holland in the past year.

These extensions alone represent an immense addition to the working capacity of the Postal Telegraph system; but it has been still further enlarged by improvements in the apparatus. Mr. Preece, in his recent lecture on American telegraphs, made a pointed reference to their backwardness as compared with the strides made in this country during recent years, a circumstance which has placed us at the head of all nations as regards speed of telegraphic transmission. An improved form of non-polarised relay has been introduced for quadruplex working; and the duplex system is now so far perfected that its application to the Wheatstone fast speed instrument has enabled a distance of 560 miles to be traversed at the rate of 240 words a minute with a repeater in circuit. The Wheatstone transmitter itself is the object of unremitting attention; and to enable the receiver to keep pace with it, the range of the train work has been enlarged so as to record at the rate of 400 words a minute—a speed which, incredible as it may seem, has actually been reached and perfect signalling obtained. Possessing such appliances as these, it may be said without exaggeration that all the existing wires now under Post Office control can be duplexed or quadrupled at pleasure; and that with the help of the Wheatstone fast speed instrument their capacity may be increased tenfold wherever and whenever the occasion or circumstances demand it.

In telephony the Post Office have kept pace with the public demand, which, however, is not very pressing. The existing exchanges have been improved, induction has been effectually cured, and the wires laid underground. Fresh exchanges are now on the point of being opened at Stockton-on-Tees, Derby, Hickley, and at Workington.

Cable Work.—The name of Lord Palmerston is still familiar to all, and an instance of his foresight will bear repeating. In 1848, in reply to a question, he said :—"The day will come when, if a Minister be asked in Parliament whether war has broken out in India, he will reply, 'Wait a minute; I'll just telegraph to the Governor-General and let you know.'" Then not a mile of submarine cable existed. Now we are grumbling because every important point is not connected by submarine wires. England has been and will be the great centre of activity in this work. All that her sons have undertaken has been in the direction of utility. All that other folks have done has been done in the game of speculation; but even those who play the game of speculation come to us to make, lay, and repair their cables. Our opinion of the multiplication of Atlantic cables is well known. There is not sufficient work for the cables at any remunerative tariff—we doubt if all the cables would be fully employed were there no tariff at all. Preparing for the increase of traffic is all very well; but, like the building of ships, it is possible to go too fast. Atlantic cables are too thick. In certain parts of the ocean the mending of one cable means the ending of another for the time being, for they overlay, and, as we have before pointed out, it is impossible in grappling in these parts to be sure of getting the right cable. But at present our tale is of the work of the year.

The three great English firms for cable work are the Telegraph Construction and Maintenance Company, Messrs. Siemens Brothers, and the Silvertown Company. The T.C. and M. Co., as it is known in short, has manufactured and laid the Saigon-Hué and the Hué-Tonking cables, having lengths of 270 and 515 nauts. respectively. The ships employed on this work were the company's ss. "Kangaroo" and "Calabria." These cables belong to the Eastern Extension Co. For the same company the Telegraph Construction and Maintenance Co.'s ss. "Seine" renewed portions of the Banjoewanjee, and also laid a cable for the Dutch Government across the Straits of Sunda—the previous cable having been destroyed during the earthquakes, which otherwise proved so disastrous in that region—the Darwin cable, the Singapore-Saigon cable, Penang-Rangoon cable. For the Brazilian Submarine Co. the Telegraph Construction and Maintenance Company manufactured and laid the duplicate Madeira-St. Vincent cable, 1168 nauts.; the St. Vincent-Pernambuco cable, 1,862 nauts., using the ss. "Scotia" and "Calabria" for the work. The Lizard-Bilbao cable of the Spanish Direct Company has been duplicated by the same company. The "Scotia" was employed in this work, and the length of cable laid was 473 nauts. The same vessel was also employed in repairing the Brazilian Submarine Company's old cable. A large quantity of cable has also been made for the Eastern Company, which the latter company has laid by its own ships. Thus, during the year the Eastern Telegraph Company has connected all the Grecian Islands, completing the net-work of cables in the Levant. Souakim and Perim are now within the cable connection; and gradually every place of importance in the East seems to be brought within the field of operations.

Turning now to the Atlantic, Messrs. Siemens have manufactured and laid the Mackay-Bennett Atlantic cables, consisting of two cables from Ireland to Nova Scotia, one cable from Nova Scotia to Rockport, Massachusetts, and one cable from Nova Scotia to New York City. The total length of these four cables is 6,100 nautical miles. It is interesting to know that the cable from Nova Scotia to Rockport, length 529 knots, contains two insulated conductors which are worked simultaneously by the arrangement devised by Mr. F. Jacob. The repair of both the main cables, which unfortunately broke soon after their completion in deep water, has been effected—a task which in the winter season in these high latitudes is one of considerable difficulty. The depths where the fractures had occurred, to the east of the Bank of Newfoundland, were 1,500 and 1,000 fathoms respectively, and in both repairs operations had to be carried on in depths exceeding 1,500 fathoms. The fractures appear to have been caused by the moving of the ground, as considerable lengths of the cable were found embedded in clay. The fact that three cables broke in deep water in the same neighbourhood during one and the same night also points to the same cause. These were :—The 1881 Gould cable, which broke on the 3rd October, at about 9 o'clock at night; the 1882 Gould cable, which broke on 4th October, at 4 o'clock in the morning; and the Southern Mackay-Bennett cable, which broke on 4th October, at 8 o'clock in the morning. The second Mackay-Bennett cable (the Northern cable) parted on 7th November, and the two Mackay-Bennett cables were repaired on 6th and 19th December respectively.

At the time of writing a successful cable-laying expedition is returning to Silvertown, and we must therefore defer our

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remarks upon the work of the SILVERTOWN COMPANY till a few more particulars of the expedition reach us.

FELTEN AND GUILLEAUME.—During the past year Messrs. Felten and Guilleaume, of Mulheim on the Rhine (for whom Messrs. W. F. Dennis and Co., 101, Leadenhall-street, London, E.C., are sole agents), have been very busy in telegraph and telephone wires, electric cables, &c., of every description. They supplied the entire requirements of the German Postal Department in telegraph and telephone wire, besides executing large export orders for telegraph wire, &c. The patent steel telephone wire manufactured by this firm is rapidly gaining favour, and is preferable to bronze wire on account of the advantages it possesses over this latter material. Messrs. Felten and Guilleaume manufacture their patent steel telephone wire in two qualities, the first with about 60 tons per square inch breaking strain, having at the same time remarkable ductility and flexibility, and the other quality with about 85 tons per square inch breaking strain, which is rather harder. The former quality they generally recommend as being best adapted for telephonic purposes, and more easily handled. The cable department of this firm has also been very busy on orders for the German Government for both underground and submarine cables, the latter for connecting some of the islands near the northern coast of the German Empire. They also laid a cable for the Netherlands Government, connecting the islands Ierschelling, Amsland, and Schiermonnikoog, besides executing a number of orders for other foreign Governments. To the telephone cable department, Messrs. Felten and Guilleaume have been devoting their closest attention, particularly to the construction of a special aerial cable, and they have succeeded in producing a cable practically free from induction. The majority of telephone companies have given it a trial, and from repeated orders it would seem to give every satisfaction. It is manufactured with from four to fifty-two conductors.

TELEPHONY.—The telephonic system is becoming, as we always considered it must, a monopoly in each district. It is disheartening to those who desire to see the best system introduced to find that the political papers, without an atom of knowledge, have used all their influence to create a system which they will shortly denounce with all the vigour at their command. We foretold—if what was quite plain can be said to be foretold—that telephony must of necessity be of the nature of a monopoly in each district. We regard telephony as merely a development of telegraphy, and we maintain that hitherto the responsible parties in London and some other large towns have not erected their lines on any rational system known to telegraphy. It is a mere hand-to-mouth makeshift, regardless of the future, and as indifferent to public safety as to private rights. We are quite sure that the overhead system is a delusion, and come what may will have to go. Attempts are made through almost every political paper that exists to force down the throats of a disbelieving public that one of the causes why telephony does not progress so rapidly here as it ought is that the companies are stopped in their endeavours to get way leaves. If so, they have only to thank their own overbearing conduct. We have been informed more than once that our opposition to the overhead wire system is official. Once for all we may say that in no single instance has the official mind been indicated to us by word, letter, or deed. We are as independent of the Government as we are of the telephone interest. What has been said and what is now said is in the interests of shareholders. Not, indeed, shareholders who are here to-day and gone to-morrow, but those who invest their money as a permanent investment. To them our warning is given. We believe that the National Telephone Company has in some cases tried underground wires, as has the Government, with fair if not complete success. If we had the framing of a policy with regard to the telephonic interest of the country, we should suggest the compulsory purchase of private interests by the State, the extension of underground wires, the lowering of rates, and the opening of every telegraph office as a telephone office. We should like to see a fair trial made of Van Rysselburghe's system upon telegraph lines that were little worked, while the Brown-Saunders system could be largely applied to lines with little telephonic work.

BLAKEY, EMMOTT AND CO.—We understand that Messrs. Blakey, Emmott and Co., of Halifax, have during the past twelve months been kept fully employed, although with the increased number of firms in the electrical business there is increased competition, and consequently in many departments less profit. In the railway department a number of good orders have been completed, and they have again obtained the whole of the London and North Western Railway Company's contract, this time for a term of years. A good business has also been done for foreign railways, especially with Warburton and Crossley's patent bell instruments, which are gaining in favour. Amongst the new instruments introduced by this firm during the year we may mention Edmonson's calculating machine, which has already elicited very high commendation from competent authorities; Fletcher's patent watchman's tell-tale, a full account of which has already appeared in this paper, and Kapp and Crompton's current and potential indicators. Magneto bell and switch-boards, &c., for the use of the various telephone companies, have also been in good demand, and there is every indication that the next year, under the fresh arrangement made by the late lamented Mr. Fawcett, will be an exceptionally good one, and that the public will gladly welcome the concessions which are being made. During the last month this firm have been removing to new and extensive premises, and have made arrangements for the manufacture of the Pilsen lamps, and Joel's patent dynamo machines, and have also erected machinery of the latest and most improved construction for the manufacture of every description of electrical apparatus, which machinery also enables them to make all the parts of their instruments exactly alike, so as to be interchangeable, a point which appears to have been almost entirely overlooked by the generality of instrument makers, although always adopted by machine makers of any repute, and a point the utility of which it is needless to dilate upon. The new works of this firm occupy a ground space of about 2,000 square yards, and the main building is six stories high.

HARRISON, COX-WALKER, AND CO.—This firm has been busy during the year, and testifies to the increasing popularity of their "tell tales" for recording the movements of watchmen, warders, attendants in asylums, &c. The experience already gained is so satisfactory that the demand is increasing. This firm has done much in the development of telephony, and, it will be remembered, carried on litigation with the United Telephone Company with regard to the originality of the Hunnings telephone transmitter. The company has proved the stronger, and removed one more opponent to monopoly in purchasing the Hunnings patent. This step led Messrs. Harrison, Cox-Walker, and Company to drop their appeal to the House of Lords regarding the Cox-Walker receiver. The firm states that "great efforts are now being made by the subsidiary companies in the district to develop telephony by means of trunk

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lines between the various towns; but until the public are able to purchase at a moderate price telephones out and out for their private use, or for use in large institutions, such as asylums, warehouses, offices, hospitals, hotels, and the like, no such development will take place as might and would under such circumstances; and the common use of the telephone in private establishments would inevitably lead to a greatly increased use of the exchange connection with others, upon which work the companies could charge and get their rentals. If the present monopolists will not do this private work, others undoubtedly will and before very long."

Messrs. TASKER, SONS, and Co., have been more especially employed in telephone exchange work and the construction of private telephone wires. One of the events of the year has been the reduction of the rates of subscription to the Telephone Exchange, with the gratifying result that more than sixty new subscribers have been added up to the time of writing, and this number is being increased almost daily. We have before referred to the Sheffield Exchange as one of the most successful private ventures in the kingdom; indeed, its position is unique. Possessing telephone apparatus in its own right, it has been able to do its business in its own way and quite independently of the large telephone companies, and we understand that it will be able to preserve its present position and to extend its operations for many years to come so far as a supply of apparatus and the means at its disposal are concerned. With 250 subscribers, the number of calls for one month have been 50,000, which shows an average of little more than ½d. per call.

ELECTRIC LIGHTING.—It is necessary to recur to this application again, and we may once more say that in mentioning specific firms our aim has been to prove to the public that work is being done. There is no other way of doing this than by stating plainly where the work has been done and who is doing it.

ELECTRICAL POWER STORAGE COMPANY.—During the past year the company have made several important developments in their storage batteries. Profiting by the experience gained in installations and the laboratory, they have modified the design of the plates to meet the many requirements of practical working. Several important advances have been made in the use of the cells for the many purposes to which they are suited. Good work has been done by means of secondary batteries in telegraphy, a large number of lines having been in constant work in London, and the cells shown to keep their charge for over three months. Owing to the great economy effected by working telegraph lines from secondary batteries, there will doubtless be a large field for their use in this way. The tramcar, driven by accumulators and Reckenzaun's motors and gearing, has been running successfully for some months at the works, and will shortly, we hear, be tried on a public line. Cells have been supplied for working electric hoists, for which they are admirably suited, as the hoist can be used at any time independently of the engine, and all transmission gearing is dispensed with. In electric lighting the use of the cells has extended considerably during the past year, and among others may be mentioned Sir W. Armstrong, at private house; Sir W. Armstrong and Co., for Italian man-of-war; Messrs. J. Edmundson and Co., Westminster, for private house lighting, &c.; Messrs. J. H. Holmes and Co., Newcastle, for private house lighting, &c.; Messrs. Siemens Brothers; the Society of Arts; C. J. Phipps, Esq., house lighting; Messrs. Waterlow and Sons, supplying arc lamps for photography; T. Nordenfelt, Esq., torpedo work; Edison Swan Company, house lighting, &c.; A. Littleton, Esq., Sydenham, private house lighting; W. Palmer, Esq., house lighting; Van der Weyde Light Company; East and West India Dock Company; J. P. Raworth, Esq., Manchester. It will be seen from the above that confidence in secondary batteries is rapidly spreading, and great progress may be expected in the coming year.

THE ELWELL-PARKER COMPANY.—During the year, owing to the increased demand for accumulators and the introduction of a new dynamo, the old firm of Elwell-Parker has been transferred to a company. The dynamo was introduced in 1883, and perhaps the latest instance of its use is that at the Stock Exchange, where three are to be found. This machine, the general form of which is now well known, has but a single layer of wire on the armature; it is practically self-regulating, as 49 lamps out of 50 may be turned off with safety to the 50th, although plain shunt-wound. There is no lead on the brushes, and the sparking is practically *nil*. Many improvements in detail have since been introduced. The accumulators (Planté and Parker-Elwell patents) have now assumed very important dimensions for large installations, some of the new cells having a capacity of 2,000 ampere hours, with a rate of charge at 200 amperes, and discharge up to 400 amperes; and this form of cell, with plates 36in. by 24in., may be economically extended in width up to at least 72in., having then a capacity of 15,000 ampere-hours, a rate of charge at 1,500 amperes and discharge up to 3,000 amperes in cases of need.

WILSON HARTNELL, LEEDS.—During the past year Mr. Hartnell has made a considerable addition to the electric lighting plant in the north of England, he having put down about 29 installations during the past twelve months. Of these six only were of arc lights. The lamps used were the Crompton-Crabb double differential brake lamps, the current used from 16 to 25 amperes. The largest of the arc installations consists of 10 lamps in series, with a current of 17 to 18 amperes. This at the present time runs for 17 hours daily. Of the incandescent installations one is with the Woodhouse and Rawson lamps, and the remainder with Swan lamps. Ten installations are in corn mills, chiefly large mills, with new roller plant, such as those of Mr. J. Ainscough, Burscough Junction, Lancashire, Messrs. Sugden and Son, Brighhouse, or Mr. J. F. Milner, Elland, Yorkshire. All the dynamos in these are Crompton-Bürgin machines. For the most part they run all night, and in a few cases day and night. Nine incandescent installations are connected with the woollen trade. At Messrs. Martin, Sons, and Co., Huddersfield, there are both arc and incandescent lights and three dynamos. These manufacturers, who are known as makers of the finest goods only, have found some purchasers willing to select and buy by the aid of the arc light. For these and the remaining installations the dynamos used have generally been Crompton-Bürgin machines, which work well. Mr. Hartnell has, however, introduced the Crompton wrought-iron machine in the *Bradford Observer* office and elsewhere. The largest of these Crompton dynamos is a 22 unit 110 volt dynamo at Mr. Charles Crabtree's, Todmorden. It runs at 480 revolutions only, and shows no visible sign of the current at the brushes. This installation illustrates the incomparable beauty of the incandescent light as compared with gas when used for manufacturing purposes. The large weaving shed (cotton), lighted by 160 equidistant pendant lights, has a fine and pleasing appearance, and gives great satisfaction to the weavers. In this installation, as in some of the others, such as Mr. Kelsey's corn mill at Gainsborough, or Messrs. Barker's factory, at Hebden Bridge, no gas has been fitted, entire reliance being placed on the electric light. In one factory, where women

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were chiefly employed, the incandescent lights have been substituted for gas, on account of the langour, headache, and faintness produced by the latter. In two cases the arc light has been added, to supplement gas light. In the one (part of a woollen mill) the employer believes that its sunny beams induce such cheefulness and activity that more work is done. In the other instance, in an engineer's erecting and tool shop (Messrs. Pollitt and Wigzell's), two of the arc lights enable heavy weights to be lifted as in the daytime, and bring the whole space in distinct review at a glance. In putting up incandescent installations Mr. Hartnell has hitherto used exclusively the somewhat expensive Thompson porcelain holder, and (with occasional exceptions) a separate cut-out to each lamp with its branch wire, in addition to Hedges' cut-outs for the mains. He spares no expense and care in the details. He considers that it is now abundantly demonstrated that the electric light can be made as trustworthy as gas, as easy to manage, and for long hours much less expensive to maintain, besides being much more satisfactory to workers, who are often enthusiastic in its praise.

SIMPLEX ELECTRIC LIGHT COMPANY.—This company has fitted up a portion of Messrs. Erwen and Roby's mill at Patricroft, near Manchester. Owing to the speed the various machines were running at, the greatest difficulty was experienced to keep anything like a steady light with gas, in fact it was not uncommon for the gas jets to be blown out. The lamps employed are Müller's, manufactured by the company. Several temporary installations by means of a portable engine have been made. Amongst other works in hand are the lighting up of Messrs. J. Robertshaw and Son's Mills, near Bradford, and Messrs. T. Ormerod and Co.'s, Haslingden.

ANDERSON AND MUNRO.—We have from time to time noted the work of this firm, and will here briefly refer to one peculiarity of their year's work. It is in the large number of extensions in places where the light has been previously introduced. Thus, further work has been done at the Earnock Collieries, at the factory of Mr. J. D. Barkay, at the biscuit factory of Mr. J. Reid, Caledonian Railway Central Hotel, &c. Such orders, as we have previously remarked, form perhaps the best proof of the success of the electric light.

F. D'A. GOOLD, MANCHESTER.—Amongst the contracts for incandescent lighting which have been completed and which we have from time to time noticed may be mentioned the lighting of "Astley Bank," Darwen, the residence of C. P. Huntington, Esq.; the Park Lane Twist Company's Mills, Preston, "Larards Still" (W. T. Grimley's new establishment), Clarence and Waterloo Hotels, Manchester, &c. In arc lighting, we may mention the Wigan Coal and Iron Company's Works, Wigan, "Larards Still" (both arc and incandescent), the erecting shop of Messrs. Sharp, Stewart, and Co., engineers, Manchester. Amongst the contracts on hand not yet finished there is the new Victoria Hotel, belonging to the Corporation of Manchester, which it is hoped will be finished early in the year. Added to this work, Mr. Goold has opened a central station for the supply of electrical energy consumed, known as the "Volta-Power Generating Works," Chatham Buildings, Manchester. At present 300 incandescent lights are worked from this source.

AUSTRALASIAN ELECTRIC LIGHT COMPANY.—The extension of the electric light in Australia seems to be making good progress, and the promise for the future is perhaps better than the performance of the past. The Australian Electric Company has been in work in Victoria about two and a half years. They have devoted considerable attention to mine lighting, and have designed for this purpose special fittings and a complete system of conductors. In this direction they have met with a measure of success. We notice in a list of installations no less than twelve gold mining companies having produced a light, besides crushing works and tin companies. It has been introduced into the House of Parliament, Melbourne, and some of the Government offices; similarly at Sydney and Brisbane, besides a number of newspaper offices, hotels, and factories.

TRAIN LIGHTING BY ELECTRICITY.

Messrs. Heenan and Froude and R. E. Crompton and Co. are lighting up a suburban service of trains for the Great Eastern Railway, and it is understood that if the lighting is successful and proves itself adapted for ordinary use, the company will extend this system of lighting to other parts of their line. The plan adopted is to place a small Tower spherical engine coupled direct to a Crompton self-regulating dynamo machine on the top of the locomotive boiler.

Both engine and dynamo are fixed on a common bed-plate and coupled direct, thus doing away with belt or wheel gearing. The whole thing is exceedingly compact, an engine and dynamo suitable for feeding fifty to sixty 16 candle-power incandescent lamps measuring only 4ft. 3in. in length, 2ft. in width, and 1ft. 3in. in height. The armature of the dynamo consists of a large number of thin soft wrought iron discs insulated from each other, and supported on radial bars of phosphor bronze, which themselves are keywayed into the spindle. The core thus formed is wound with insulated copper wire in the manner of a Gramme ring, care being taken to leave sufficient open space for ventilation. The field magnets are of the softest Swedish wrought iron thoroughly annealed, and the winding is put on by means of detachable formers, thus making the changing a coil, should one ever get damaged, a very easy matter. Up to the present, however, no mishap of any kind has occurred to any of the dynamos which have been at work for the last two months. The dynamos are wound on what is known as the compound system, and are therefore self-regulating—that is to say, if driven at a constant speed they will light one or fifty or any intermediate number of lamps, with the same brilliancy in each lamp, requiring no regulation whatever on the part of the driver. To keep the dynamos running at a constant speed a centrifugal governor is fitted to the engine, and all the locomotive driver has to do is to turn on the steam into the little engine when the light is required, and then leave the apparatus to itself. It is not easy to give a description of the Tower engine without the aid of diagrams, suffice it to say that all the moving parts of this remarkable engine are contained within a sphere of 5in. internal diameter, only the shaft protruding. The pistons are semi-circular discs, having a rotary and oscillating motion combined, and the admission and exhaust of steam is effected without the use of a separate slide valve.

The engine and dynamos are placed on top of the locomotive, and steam is taken from the locomotive boiler. A pair of cables well insulated and provided with clip couplings in front and rear of each coach extends throughout the train, and smaller wires are attached to this main for feeding the single lamps.

The lamps are of 16 candle-power each, placed in the roof of the carriages in the same openings which used to serve for the reception of the old-fashioned oil lamps, and the connection with the wires is made automatically by simply dropping the globe containing the incandescent lamp into place. An improvement is now being introduced, whereby the lamps will be fitted from the inside of the carriages instead of from the outside, thus doing away with the necessity of men getting on to the roof.

The system has been in successful operation for the last two months, and it is believed will prove a great success.

PERSONAL.—Messrs. H. E. Harrison and C. J. Wilson, of the Hammond Company Electrical Engineering College, will in future carry on their consulting practices at the Hammond Company's College.

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CORRESPONDENCE.

TELEPHONING SERMONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice some remarks in your issue of this date respecting the transmission of sermons by telephone, and giving June, 1882, as being the date on which they were first so sent.

I may say that I fitted up my patent microphone transmitters in the chapel here, of which the late Dr. Mellor was minister, as long ago as January, 1879, since which period they have been in constant Sunday use. On Easter Sunday in the same year the sermon was transmitted along the wires of the Lancashire and Yorkshire Railway to Manchester, a distance of thirty-two miles. The Manchester papers of the morning following contained an account of the experiments. With one of Edison's chalk receivers, I am able by special arrangements to reproduce the sermon loud enough to be heard from one end of my billiard room to the other.

Perhaps you would kindly insert this in your next publication.—Yours, &c,

LOUIS J. CROSSLEY, M.S.T.E.

Moorside, near Halifax, Jan. 3, 1885.

HEATING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice an interesting letter from Mr. Sellon in your issue of to-day; and to warn many who may follow in the steps therein indicated without due consideration I am tempted to address this letter to you.

Electricity for heating purposes cannot for one moment be seriously thought of at present, if a steam or gas engine is used to produce the current in the first instance.

In the first case, one-tenth of the heat of the coal only is recovered; then, say, 25 per cent. of power is lost in the dynamo; and finally, 25 per cent. or more lost on conversion of the current into heat. Thus we get $0{\cdot}1 \times 0{\cdot}75 \times 0{\cdot}75$ of the heat of the coal $= 0{\cdot}05625$, or say, at best, $\frac{1}{20}$ only. Even if coal were burnt in an open fire-place, not more than half the heat is lost. With a gas engine matters are not much better. In short, taking the expense of machinery, &c., into consideration, it is fair to assume that heating by electricity is at least 50 or 60 times more expensive than burning coal direct in the most approved stoves, and 25 to 30 times dearer than coal burnt in an open fire.—Yours, &c., DAVID SALOMONS.

Broomhill, Tunbridge Wells, Jan. 3, 1885.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The communications of Professor Dolbear and Mr. Sprague in your last two numbers mark a satisfactory advance in the attitude of skilled observers towards the new and urgent question of personal safety and electric currents. Each of the correspondents, however, tends to accentuate, and probably to overstate, his partial view of the whole problem.

It may be worth while to reprint part of a letter of mine which appeared in the *Globe* of August 7th last, and to which I still substantially adhere:—

"A new industry, and a fresh industrial danger, has arisen among us from the use of enormous electrical current. Although several startling accidents have already occurred, no means have been adopted, so far, for tracing them to their real cause, and thus preventing their recurrence. The lightning explanation is obviously not tenable as regards some. I have already stated that actual catalysis, or decomposition of the body, is not impossible, and that probably thrombosis, or coagulation of blood in the living vessels, occurs in other cases. I found it, however, as you state, very difficult to obtain trustworthy details. Mr. Latimer Clark, the eminent telegraph engineer, has promised to help me. But it is important that public attention should be drawn to the question, as with longer use, wear of machinery, failure of insulation, and natural negligence, due to greater familiarity, it is not unlikely that such accidents will increase rather than diminish in frequency."

Both the writers above named ignore the immense error hitherto made in the estimation of human resistance. Mr. Sprague, indeed, reasserts erroneous statements with a cautious qualification. A patient tested yesterday in hospital gave, from foot to foot, with alternate currents on Professor Kohlrausch's meter bridge, a resistance of 620 ohms, instead of 5,000 ohms, per Sprague's minimum. Salt water was used to overcome the transitory deception and dangerous skin-insulation. A workman, with his hands freshly removed from dilute sulphuric acid, would give a smaller figure.

From experiments made last week in Professor Stocker's laboratory at Cooper's Hill, in conjunction with Mr. W. G. Gregory, "it appeared," to use Mr. Gregory's own words, "that with the coil developing a mean E.M.F. of 9·02 volts, on touching the terminal with my fingers I experienced a decidedly uncomfortable tingling. Now, although the mean E.M.F. may be only 9·02 volts, yet I believe that the maximum E.M.F. at some instants must be very much greater; and it is this maximum which we want to get at."

This I believe to be true, but not the whole truth. Professor Dolbear states correctly that time and work both need to be considered.

I should add that the cause of danger is not always or necessarily the same; indeed, there is good evidence to this effect.

Mr. Sprague's statement that "the real danger is due to a physiological effect of the static actions which accompany the setting up of the difference of electric potential" *may* perhaps be true in the case of shock; but, before admitting it, even in a limited degree, it is desirable to know what is the "physiological effect," and what are the "static actions" thus mysteriously indicated.—Yours, &c., WILLIAM H. STONE.

St. Thomas's Hospital, December 3rd.

BATTERY FOR LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last number Mr. Andrews asks for "a battery (not Grove or Bunsen)" to run an incandescent lamp. I suppose that Mr. Andrews excludes the Bunsen on account of the noxious fumes that it gives off.

I would propose a modification of this battery, due to Mr. d'Arsonval. It has a high E.M.F. (two volts), a low resistance, is constant on a short circuit, and has the advantage of giving off no noxious fumes, although it smells a little of chlorine.

In an ordinary Bunsen cell put in the porous jar—nitric acid, one part (by volume); muriatic acid, one part; water, with one-twentieth of sulphuric acid, two parts. Outside the porous jar with the amalgamated zinc—water, 20 parts; sulphuric acid, one part; muriatic acid, one part. A cell 8in. high has a resistance of one-tenth of an ohm, and will furnish *without weakening* 28 ampere hours.—Yours, &c.,

110 Bis., Br. Malesherbes, Paris, Jan. 4, 1885. H. O. BAILEY.

PROFESSOR FORBES'S PAPER ON THE DIAMETER OF CONDUCTORS—A NUMERICAL CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It will be remembered that Professor Forbes's important paper on the diameter of conductors to prevent overheating—a paper whose great value has been recognised by the S.T.E. and E.—contained some rather alarming conclusions respecting the mass of metal required to convey very large currents by the underground conductors. The importance of the question must be my apology for venturing to call attention to a numerical error which occurs in the professor's approximate solution of this problem. He arrives at the formula

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$C^2 = \frac{b^2}{80\,R}$, where b is the width (in centimetres) of a conductor assumed to be 1 c thick, and R is the specific resistance of the metal at an assumed temperature of 65° C. For copper $R = 2 - 0{\cdot}31 + 10^{-6}$ ohm.

We have, therefore,

$$C = \frac{b \times 10^3}{\sqrt{162{\cdot}48}}.$$

C is then put = 25 b, whereas the true value is C = 78·46 b.

It will be found that the error arose from the misplacement of a decimal point before extracting the root.

The specimen table which immediately follows (in the original paper) is calculated from this erroneous value, and shows that a copper conductor 1c. thick to convey 70,000 amperes would have to be 28 metres in width. The corrected value is 8·9 metres, which still leaves a substantial mass of metal, weighing about 1½ ton, per lineal foot.—Yours, &c.,

Tiverton, Devon. W. H. SNELL.

ELECTRO-MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am but a poor little working unit in this wonderful world of ours, yet I have my own ideas and wants; and amongst the latter are some "wants to know," and, kind Mr. Editor, I on behalf of several fellows in our office am to ask you to help us to get to know. I was talking the other day to an old office chum of mine—Mr. Unit Field—about our income-tax assessment, and he told me that he had but a very hazy notion as to what he was really worth, and he said, "I cannot really tell you until I have gone into the books of our concern; and it is very funny that Mr. Magnetic Moment is in pretty much the same difficulty. Of course your value here is fixed very clearly, but we less practical folk have very vague ideas about our true position." Well, Mr. Editor, from one thing to another our talk led (we are an electrical firm) to some remarks about electro-magnets, and I found that Mr. Unit Field was interested in designing some. He asked me a question or two that I really thought I knew all about, but I did not. He had entered into the design of an electro-magnet that was to have a certain strength—I forget now whether it was intended to lift a weight, or to induce a current in the armature of a dynamo machine; but, anyhow, he wanted to know what size the iron should be, and what number of turns of wire he should put on, and what current he should use. Now, it is so very funny that these fellows, Unit Field and his friend Magnetic Moment, although they have to do with these things every day, don't know how to work this out; and I, too, who have something to do with these things, can't help them. He suggested that the new fellow, Gauss, might help us; so we turned into his room, where we found him reading the paper—for being new his duties are little known to the others yet. But we could not get much from him, so we all went to the Patent Office Library together to look the matter up. When we got there we thought we had found all we wanted to know, for there were scores of papers relating to the subject, filled with those beautiful "double fiddle f's" that always give so much information; but after a long afternoon there we came away, feeling very much as if we had been eating pasties, puffs with no jam to speak of inside. Now, Mr. Editor, won't you or some of your good readers help us?—Yours, &c.,

VOLT AMPERE.

DOMESTIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: A short time ago, through your columns, I obtained a very fair idea of the cost of "private electric installations for lighting," which were, on the whole, very satisfactory—in fact, a great advance on district or large area installations, as regards private individuals.

Since that time, in your impression of December 27, 1884, I have seen your article on the "Trouvé lamps."

After considering all points, I think an advance has been made in "domestic lighting," or can be developed more easily than could have been expected.

Companies have failed, and, from their constitution (in my opinion), must continue to do so; but electric lighting, both in large and small areas, must, and, despite of every obstacle, will advance. I therefore hail with delight the "development" of the Trouvé system as regards small domestic lighting.

As regards "the Trouvé system," therefore, would you kindly, through your columns or by correspondents, inform me as to 1st, the prices of the three portable lamps (Trouvé) on page 129, Vol. XIV., No. 7; 2nd, the sizes of each three descriptions; 3rd, the time, *i.e.*, number of hours, for which they respectively last.—Yours, &c., G. E. R. HARRIOTT.

12, Alexandra-place, St. Andrews, Fife, N.B.
January 7, 1885.

DR. ARON'S COULOMB-METER.

In a paper read before the German Society of Electricians, Dr. Aron described his new electricity counter, or Coulomb-meter, which, in point of simplicity of construction and accuracy in its indications, would seem to be the best of any integrating instruments yet devised. A complete theory of this apparatus will be found in the December number of the *Elektrotechnische Zeitschrift*, but we propose to give here a short abstract of it.

The meter consists of an ordinary pendulum clock, the pendulum of which carries a permanent steel magnet instead of the usual bulb, which magnet swings over a wide coil traversed by the current to be integrated. In so far the arrangement is similar to Messrs. Ayrton and Perry's ergmeter. There is, however, this difference, that by the employment of a magnet instead of a shunt coil, current is integrated instead of energy, and that the main coil is not behind the pendulum but below it, an arrangement for which Dr. Aron claims that the dynamical pull of the coil is exerted in the same direction as the force of gravity. The number of oscillations performed by the pendulum in t seconds if no current passes is

$$n = \frac{t}{\pi}\sqrt{\frac{PL}{K}}$$

where P is the weight, L the length, and K the moment of inertia. Let M be the magnetic moment of the magnet, C the current, and α a coefficient, then we obtain the number of oscillations performed by the pendulum in the same time if a current is passing

$$N = \frac{t}{\pi}\sqrt{\frac{PL + \alpha M C}{K}}$$

or

$$N = n\sqrt{1 + \frac{C}{\beta}},$$

if for brevity we write

$$\beta = \frac{PL}{\alpha M}.$$

The apparatus is so arranged that the magnetic attraction is small as compared to the weight, and therefore $\beta > C$ in all cases. By developing into a series it is permissible to neglect higher power than the second of $\frac{C}{\beta}$, and we obtain

$$N = n\left(1 + \frac{C}{2\beta} - \frac{C^2}{8\beta^2}\right)$$

The coulombs passed in t seconds equal t C, and since n and t are in a fixed ratio to each other, the quantity of electricity is also proportional to n C. By transforming the above equation for N, and introducing the symbol Q for coulombs, we obtain

$$2\beta(N - n) = Q\left(1 - \frac{C}{4\beta}\right).$$

From this equation it will be seen that the difference between the number of oscillations performed by the pendulum with and without a current passing is not strictly proportional

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to the quantity of electricity, but is too small for the larger currents, the error being $\frac{100\ C}{4\ \beta}$ per cent. To minimise the error it would be necessary to make β very large as compared to C—that is, to employ a very heavy pendulum and a very small magnet; but then the rate of acceleration of the clock would be too small as compared to variations due to temperature and other disturbing causes, and the instrument would become inaccurate on account of these. The clock employed by Dr. Aron had a pendulum beating 80 times a minute, and the acceleration varied with different currents, but never exceeded 240 beats per hour. The maximum rate of advance was therefore three minutes per hour. The errors found in a long series of experiments varied between 2½ and 8 per cent., but instead of being negative, as should be expected from the formula, they were found to be positive, the reason being that the stronger currents temporarily increased the moment of the magnet, and thus accelerated the clock beyond the rate which would have to be expected with an absolutely unchangeable magnet. The remedy lay near and was at once applied by substituting a magnet just hardened sufficiently so that its temporary magnetic moment should suffice to eliminate the error. Dr. Aron seems to have succeeded well with this arrangement, as may be seen from the following table, giving the results of experiments extending over two days:—

	Ampere hours.	
Current in amperes.	By coulomb-meter.	By calculation.
23·2	11·6	11·6
13·8	11·1	11·0
9·6	−0·1	0·0
4·9	9·8	9·8
2·4	7·2	7·3
0·96	3·8	3·8

The author further describes his energy meter, designed on similar lines. The bulb of the pendulum is replaced by a coil of fine wire connected as a shunt to the mains, the convolutions of this coil being vertical. Two main coils, one on each side, are so placed that the shunt coil partly enters into them at each beat. A small piece of soft iron is added to the pendulum, in order to introduce the correction as above explained. The results obtained with this apparatus are also extremely satisfactory. We need not reproduce here a rather long table of readings, but must be content to note that in a trial extending over three days, the total energy indicated by Dr. Aron's meter amounted to 28·70 megawatts, whilst the energy computed from current and electromotive force was found to be 28·63 megawatts. During the tests the current varied between 2·35 and 22·2 amperes and the E.M.F. between 50 and 100 volts.

TRANSFORMATION OF ENERGY INTO CURRENT.

J. Van Moorsel contributes the following observations to *L'Ingenieur-Conseil*:—According to the data of thermo-chemistry, the quantity of heat disengaged by the combination of a zinc equivalent (or rather half-equivalent, since zinc is diatomic) with its corresponding weight of oxygen, equals 42·63 small *calories* (32·5 grammes × 1·3 *calorie* = 42·63); and that disengaged by the sulphatation, 10·24 *calories*, making together 52·87 *calories*, the quantity of heat disengaged by the combustion of 1 gramme (15½ troy grains) of zinc being 1·3 *calorie*. From this quantity must be deducted 34·4 *calories* for the heat absorbed by the decomposition of an equivalent of water. There remain 18·41 *calories*, which correspond with the E.M.F. of a Smée couple (zinc-platinum with diluted sulphuric acid). Now, if I perform the inverse operation to that which takes place in the Smée couple, if I electrolyse a sulphate of zinc solution, the metal will be deposited on the negative electrode, and the acid will go to the positive pole. Instead of producing the current, it is the electricity which will be consumed. This current will have to overcome—1. the resistance inherent in the electrode; 2. the resistance to electrolysis without chemical decomposition (inverse electromotive force); and 3. that which causes the decomposition. These three resistances consume a certain quantity of energy, the first of which is pure loss, at any rate as regards stored-up current. Thus, for the decomposition or water, an E.M.F. of 1·46 volt would be required for the resistance of an ohm. The electrolysis of sulphate of zinc furnishes the elements of a Smée couple; it is therefore evident that the energy restored by the current of this element will only be a small portion of that expended, or 35 per cent. The electrolytic action only stores up 45 per cent.; it must therefore absorb 45 per cent. of the 35, or 15¾ per cent. of the initial mechanical energy. This doubtless supplies one of the reasons why attempts at storing current by means of gas batteries have not been successful. Another cause must be sought in the heat produced by the compression of the gases, when working under pressure, as must be the case so as to render the apparatus less cumbrous, if practical applications be hoped for, such as the propulsion and steering of balloons, for instance.

THE DRAWBAUGH TELEPHONE CASE.

AMERICAN BELL TELEPHONE COMPANY AGAINST THE PEOPLE'S TELEPHONE COMPANY ET AL.

The following is the decision of Judge Wallace in this case. We give the decision *verbatim* for the historic value it will necessarily have:—

The suit is brought to enjoin the defendants from using, and furnishing to others for use, the several inventions described in two patents granted to Alexander Graham Bell, of Salem, Massachusetts, being No. 174,465, bearing date March 7, 1876, for "Improvements in Telegraphy," and No. 186,787, bearing date January 30, 1877, for "Improvements in Electric Telephony." The issues made by the pleadings are practically resolved into the single question, to which the proofs and arguments of counsel are mainly addressed, whether the patentee Bell, or Daniel Drawbaugh, of Milltown, in Cumberland County, Pennsylvania, was the first inventor of the electric speaking telephone.

Concededly Bell was an original inventor of the telephone, the principle of which, with the essential means for its application, are described in his first patent, and of the improved apparatus described in his second patent. The fifth claim of the first patent is for "the method and apparatus for transmitting vocal or other sounds telegraphically by causing electrical undulations similar in form to the vibrations of the air accompanying the said vocal or other sounds substantially as set forth." This patent has been judicially construed in two cases in the Massachusetts Circuit; and in both cases it was substantially held that Bell was the discoverer of the new art of transmitting speech by electricity, and the claim should receive the broadest interpretation to secure to the inventor, not the abstract right of sending sounds by telegraph without regard to means, but all means and processes described which are essential to the application of the principle. American Bell Telephone Company *v.* Spencer, 8 Fed. Rep., 509. Same *v.* Dolbear, 5 Fed. Rep., 448.

In view of the conclusion reached upon the merits of the issue it is not material whether Bell's inceptive invention did or did not antedate the time of filing his application for the first patent. That application was filed February 14, 1876. It describes apparatus which was an articulating telephone whether Bell knew it or not. Mr. Cross, an expert, caused apparatus to be made in conformity to the descriptions and to drawings as shown in Fig. 7 of the patent, which proved itself to be an operative, practical telephone. Probably the date of his inceptive invention might be carried back to July, 1875, but irrespective of the time of the invention the justice of his claim to be an original inventor of the telephone must remain unchallenged. It was through him also that the telephone was made known to the scientific public, and thence introduced into commercial use.

The defendants contend that long before Bell had perfected his invention, and long before its mental conception by him, Drawbaugh had not only made the same invention, but had perfected improvements in organisation and detail which Bell has never reached, and which were only reached years afterwards by the work of many other inventors in the same field of improvement. Their theory of the facts is stated with substantial accuracy in the answer to the bill of complaint. The answer, among other things, avers that Drawbaugh was and is the original and first inventor and discoverer of the art of communicating articulate speech between distant places by voltaic and magneto electricity, and of the construction and operation of machines and instruments for carrying such art into practice; that the said electric speaking telephones so constructed and successfully and practically used by him contained all the material and substantial parts and inventions patented in the two patents granted to Bell, and also contained other important and valuable inventions in electric and magneto telegraphy; that some of the original machines and instruments invented, made, used and exhibited to many others long prior to the alleged inventions of Bell are still in existence and capable of successful practical operation and use, and are identified by a large number of persons who personally tested and used, and know of their practical operation and use in the years 1870, 1871, 1872, 1873, and 1874, and both subsequently and prior thereto; that said Drawbaugh for more than ten years prior to 1880 was miserably poor, in debt, with a large

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and helpless family dependent upon his daily labour for support, and was from such cause alone utterly unable to patent his said invention or caveat it, or manufacture and introduce it upon the market; and that said Drawburgh never abandoned his invention nor acknowledged the claims of any other person thereto, but always persisted in his claim to it, and intended to patent it as soon as he could obtain the necessary pecuniary means therefor.

Drawbaugh, in his testimony, adopts the statements of the answer as true. He also testifies that he commenced his experiments with the electric telephone as early as 1866; that prior to or as early as in 1867 he had made apparatus (in which he employed a teacup as the body of the instrument), through which speech could be transmitted feebly and incoherently, and that as early as the birth of his son Charles he had so progressed that his wife, who was then confined to her bed, could by listening with one of his instruments hear the words spoken by him in the other instrument in a distant part of the house. His son Charles was born in 1870, and if Drawbaugh's narrative is true he had succeeded at that time in transmitting speech distinctly through his instruments, although whispered words would not be accurately heard. He describes instruments which he says were made by him from time to time as experiments led him from one improvement to another. He testifies that he thinks he made his first telephone apparatus prior to November, 1866, and is positive he had it before he moved his shop to the "Clover Mill" in 1867. As he describes it, the body of the transmitter was a porcelain teacup, the diaphragm was of membrane, the electrodes interposed in the circuit were copper, with the upper one connected to the diaphragm by a wire so as to vary the pressure of a conductor of fine earth or pulverised charcoal through the action of the sound waves, and the receiver was a tin can without a top or bottom, having a membrane diaphragm stretched over one end connected by a tense cord to an armature supported on a spring, and arranged close to the poles of an electro-magnet in the electric circuit. He testifies that subsequently he constructed apparatus upon the same general principle with some change of detail, and he produces exhibits "F" and "B," the former a transmitter and the latter a receiver, as the remnants of the original instruments. Exhibit "F" is a glass tumbler; and he states that at first he used a membrane diaphragm over it, and then one of thin metal, and that for the conductor he used carbons, or carbons mixed with bronze powder, and used various tops or mouth pieces to speak into it. The exhibit "B," he says, was the receiver, and in this he had discarded the string and the spring of his earlier receiver. He says that experiment led him to improve the transmitter "F" by substituting a metal diaphragm in place of membrane, and he produces a sketch. A reproduction of this instrument has been made by him for use in the proofs, "which is designated as Exhibit F reproduced." In this the mouthpiece is modified in size and in distance from the diaphragm. He made, according to his testimony, a new receiver of more perfect construction, and produces the remnant of the original, which is designated "Exhibit C." As he describes the instrument it was a decided advance upon the former receiver. In using this he says he tested it also as a transmitter with some success, and then improved it by placing a permanent magnet against the heel of the electro-magnet, and thus made a magnetic telephone. A reproduction of such an instrument as he describes is made and referred to in the proofs as "Exhibit reproduced C." After Exhibit "C" he produces "I," "A," "E," and "D," as likewise original instruments made respectively in the chronological order of their production as exhibits. He states that "I" was used by him as a companion instrument to "C." Exhibit "A" discloses a modification of form and a higher degree of mechanical adaptation. The last two, "D" and "E," are concededly perfect, practical instruments, and according to the testimony of Mr. Benjamin, an expert witness for the defendants, would compete successfully for public patronage with any magneto telephone which had been introduced into use in 1882. It is asserted of these instruments by counsel that no higher development of the telephone has been reached at the present time than is indicated by Exhibits "E" and "D." Drawbaugh does not attempt to locate the time at which he made any of these instruments, or even the year. He testifies, however, that he made all of them prior to the time the "Axle Company" commenced business, which was in December, 1874, except "E" and "D," which were made about that time.

The theory of the defendants is, that Exhibits "F" and "B" were used by Drawbaugh in 1867, 1868, and 1869, Exhibit "C" in 1869 and 1870, Exhibit "I" in 1870 and 1871, Exhibit "A" in 1873 and 1874; and that Exhibits "E" and "D" were made in January or February, 1875, although cruder instruments essentially similar were made somewhat earlier. It is in proof that 33 patents were granted for improvements in telephones in 1878, 64 in 1879, more than 100 in 1880, and 94 in the first six months of 1881. According to the theory of the defendants, therefore, as early as February, 1875, Drawbaugh had not only distanced Bell in the race of invention, but also Gray and Edison, and had accomplished practically all that has since been done by a host of other inventors.

The case for the defendants must stand or fall by this theory. The proofs leave no room for fair doubt that defendants' contention is substantially true, or that the defence has no foundation in fact. It is true that Drawbaugh had long been treading his solitary path of investigation and experiment in poverty and obscurity, but had perfected his work when the inventions of other explorers were in embryo, or his story is an ingenious fabrication. And, as will hereafter appear, if the defence is a fabrication many disinterested witnesses have contributed innocently to give it colour and strength, but Drawbaugh has deliberately falsified the facts.

The complainant starts with the benefit of the presumption of law that Bell, the patentee, was the inventor of that for which the letters patent were granted to him. Whoever alleges the contrary must assume the burden of the proof. Evidence of doubtful probative force will not overthrow the presumption of novelty and originality arising from the grant of letters patent for an invention.

It has been frequently held that the defence of want of novelty or originality must be made out by proof so clear and satisfactory as to remove all reasonable doubt. Washburn *v.* Gould, 3 Story, 227; Smith *v.* Fay, 6 Fish, 446; Hawes *v.* Antisel, 2 B. and A., 10; Patterson *v.* Duffy, 20 Fed. Rep., 641; Wood *v.* Cleveland Rolling Mill Company, 4 Fish, 560; Parham *v.* American Button Hole Company, 4 Fish, 482; In U.S. Stamping Company *v.* Jarrett (18 Blatch, 469), Blatchford, J., said the defendant had not fulfilled "the necessary obligation of showing beyond any reasonable doubt" that Weber (the alleged prior inventor) was prior to Heath (the patentee). In Coffin *v.* Ogden, 18 Wall, 129, Mr. Justice Swayne, delivering the opinion of the Court, stated the rule applicable to the defendant as follows:—"The burden of proof rests upon him, and every responsible doubt should be resolved against him."

To overthrow this presumption and disprove that Bell was the first inventor the defendants introduce the testimony of nearly 200 witnesses tending to prove the priority of invention by Drawbaugh. As the complainant concedes that Exhibits "E" and "D" are highly organised practical telephone instruments, and fully capable of perfect articulation, the patents are invalidated if these instruments were in existence at the date of Bell's invention; and as will hereafter appear they were in existence as early as in 1875, or it is incredible that they existed at all until long after Bell's first patent had been granted, and his invention had attracted general public attention at the Centennial Exposition and elsewhere.

In the argument for the defendants great stress is placed upon the evidence of a gradual and natural development of Drawbaugh's invention shown by the original instruments produced, beginning with Exhibit "B" and ending with the perfect magnetos "E" and "D." It is strenuously urged that these exhibits fortify his testimony describing the instruments no longer extant, and mark the origin and culmination, beginning with the cup machine and Exhibit "F" of two separate lines of invention—one leading to the battery telephone, in which the undulatory vibrations are controlled by variations on the resistance of the circuit, and the other to the magneto-telephone in which the vibrations are created in the electromotive force of the current.

The general theory of the defence is substantiated by three classes of witnesses; those who heard of the existence of Drawbaugh's "talking machines" at various times; those who talked through the machines on various occasions or heard others talk through them, and those who attempt to identify one or more of the exhibits as the instruments they saw or used. Only an outline of their testimony will be given.

More than fifty witnesses testify to having heard of the talking machines prior to February 14, 1879.

Of these witnesses three think they heard of them in 1869; three in 1870; two in 1871; five in 1872; three in 1873; three prior to 1873; eight in 1874; two in 1875; from 1866 to 1876, one; from 1868 to 1871, one; from 1868 to 1873, one; from 1869 to 1870, one; from 1869 to 1876, one; from 1871 to 1872, two; from 1872 to 1873, one; from 1873 to 1874, one; from 1873 to 1875, three; from 1874 to 1875, one; from 1874 to 1876, one; from 1872 to 1876, one; prior to 1869, one; prior to 1872, two; prior to 1875, one.

Sixty witnesses do not attempt to identify any particular instrument, but testify that they saw a talking machine or talked through it or heard it talked through at Drawbaugh's shop on occasions subsequent to 1867, and most of them fix the occasion as prior to 1876. The substance of the testimony of some of them will be given.

Wilson G. Fox testified that he saw the talking machine at Mr. Drawbaugh's shop about the year 1867 or 1868, when the old Faucet Company was in operation there. Prior to March, 1871, the witness was employed in the carding room of the Harrisburg cotton mill, and Drawbaugh came there to get material to wrap his wire to use for the talking machine. Henry Bonholtzer testified that he was at Drawbaugh's shop in 1869, and saw talking machines there. Margaret Brenneman testified that she saw the talking machines at Drawbaugh's shop in 1869. Abraham May testified that he did work on Daniel Hart's house at Milltown in August and September, 1870, of which he produces his account books; that he never did any work for Daniel Hart after that; that while doing that work he was at Drawbaugh's shop to get a boring machine mended which he was using in the work, and Drawbaugh showed him his talking machines, and talked through them from one floor of the shop to another. The witness understood and heard through the machines the words that Mr. Drawbaugh spoke into it. His testimony is corroborated by Jacob H. Kilmore, William H. Martin, and John A. Smith. Cyrus Orris testified that he saw Drawbaugh's talking machines at different times from about the 1st of April, 1871, down to 1880, and took his son-in-law, Jacob E. Smith, to Drawbaugh's shop to see the machines about April 1st, 1871. Benjamin K. Goodyear testified that in 1871 he seized the personal property of George W. Kissinger, of Milltown, upon an execution issued November 13, 1871; that on December 4, 1871, the attached property was appraised, and on that day witness went to the workshop of Daniel Drawbaugh to find J. B. Drawbaugh to summon him as an appraiser, and had to wait for him there a short time; that while waiting there Daniel Drawbaugh showed him his talking machines, and talked through them to him, and witness heard him speak and understood distinctly the words that he spoke through the instrument; and that he was never in Drawbaugh's shop afterwards so far as he can recollect. George Natcher testifies that he lived at Milltown in 1871 and 1872, and never has been in the town since August 9, 1872; that while living there he was at Drawbaugh's shop and saw and talked through the talking machine on different floors, and listened at the same machine and understood what was said through it. Mrs. B. B. Spangler, a sister of George Natcher, testifies that she moved away from Milltown in 1872,

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and never has been there since; that she talked into Drawbaugh's talking machines while she lived there; and that she was so small that Harman Drawbaugh had to lift her up to enable her to talk into the machine. Mrs. Mary Free testifies that she was with her sister, Mrs. Lydia Drawbaugh, at Drawbaugh's shop in September, 1872, when he talked through the machines to them, and she remembers hearing through the machines, "Good afternoon, ladies!" Drawbaugh told them that the machines operated by electricity. Mrs. Lydia Drawbaugh testifies that she saw the talking machines in September, 1872, her sister, Mrs. George Free, being present. David M. Ditlow testifies that he saw Drawbaugh's talking machine about 1872, when Drawbaugh talked through it, and witness heard and understood through the machine what he said. David K. Ernest testifies that he was at Drawbaugh's shop with John B. Bloser about the middle of June, 1872, and talked with Drawbaugh about the talking machines, and thinks he saw them at that time. This testimony is corroborated by John Bloser. N. W. Kahney testifies that he saw the talking machines about 1872. William H. Martin testifies that he was at Milltown with John Keefauver to get George Hosler to make him a pair of boots. Hosler lived at Milltown only from March, 1872, to March, 1873. At that time witness and Mr. Keefauver went down to Drawbaugh's shop and talked through the talking machine from the basement to the attic, and heard and understood what was said through the machines. They talked and listened at the same instrument. John F. Keefauver corrobates Mr. Martin, and also states that he talked through Drawbaugh's talking machine with Jacob M. Sadler in April, 1873, prior to the death of George B. Hick, and that about two or three years before he saw the talking machines he had heard a good deal about them, and first heard of them at a place seven miles west of Carlisle. Wm. W. Snyder testifies that he was at Drawbaugh's shop on Wednesday, Feb. 5, 1873, and saw the talking machines. He verifies the date by an entry in his diary. Jacob Barber testifies that he was a candidate for the office of County Commissioner of Cumberland County in the summer of 1873, and in connection with his canvass went to Drawbaugh's shortly after the death of George B. Hick. While at Drawbaugh's shop he saw the talking machine and was never in the shop after July or August, 1873. Ezekiel Worley testifies that about the year 1873 he saw the talking machines at Drawbaugh's shop. His statement is corroborated by John K. Taylor. Abraham Ditlow testifies that he knew of Drawbaugh's talking machine in 1874, and saw it and talked through it at that time. He had forgotten the fact, but was reminded of it by Mr. Alexander Milner, of Porter County, Indiana, whom witness told about it in May or June, 1876, in Indiana. William Eppley testifies that he visited Drawbaugh's shop for the last time in May or June, 1875; that he was there several times during the two years preceding that period, and had seen talking machines. Jonathan Fry testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Frederick in the winter of 1875-6, and saw the talking machines there. Jacob Evans testifies that he was at Drawbaugh's shop with his wife, his brother Andrew, and his sisters Margaret and Sarah about December 1, 1875, and saw and talked through the talking machines. Henry L. Hamme testifies that he was at Drawbaugh's shop either in the last of January or the beginning of February, 1876, in company with George Frederick and Jonathan Fry, and saw and talked through the talking machine at that time; that he heard and understood very plainly what was said through the machines, even when Mr. Drawbaugh talked in a whisper. George Frederick testifies that he was at Drawbaugh's shop with Mr. Hamme and Mr. Fry in January or February, 1876, and saw the talking machine. S. S. Rupp testifies that he was at Drawbaugh's shop with Mr. Hammacher and his scholars on February 1, 1876, and recollects that Mr. Drawbaugh at that time spoke about a machine that he had which he called a talking machine, but the witness was interested in other things, and did not pay much attention to it. George H. Bowman testifies that he saw talking machines in Drawbaugh's shop in February, 1876, at which time somebody was talking to Mr. Drawbaugh through them. Charles L. Drawbaugh testifies that he saw and talked through the talking machines at Drawbaugh's shop a year or more prior to May 1, 1876, and heard and understood what was said.

(TO BE CONTINUED.)

COMPANIES' MEETINGS.

The Consolidated Telephone Construction and Maintenance Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held at the offices of the Company, 109, Farringdon-street, on Tuesday last, for the purpose of confirming the resolutions passed at the adjourned third ordinary general meeting, held at the Cannon-street Hotel, on Tuesday, the 16th December, 1884. Mr. C. L. W. Fitzgerald occupied the chair.

The SECRETARY (Mr. Charles Curtoys) read the notice calling the meeting and the resolutions which had to be confirmed.

The CHAIRMAN: Gentlemen, before I put these resolutions for confirmation to the meeting, I should like to say a word or two on the subject of the River Plate and Austria. Mr. Powers, our manager at the River Plate, has arrived in England, and, from conversations I have had with him, he has entirely altered that which I thought possible, namely, that there was a chance of strong opposition there against us. Now, on the contrary, I believe the opposition is anything but strong; and the reason I think why that is so is this, that some eighteen months ago a proposition was made to amalgamate the two companies on the basis of 33 per cent. to our business against 66 per cent. to theirs. That was declined. We, on our side, proposed amalgamation on the basis of one-half. The opposition declined that. Later on the opposition came to us and offered to amalgamate on the basis of one-half. We say "No, we will amalgamate with you on the basis of gross receipts," and to my mind that seems the fairest way that we could possibly settle the question. The business appears to be flourishing, and we keep on getting in fresh subscribers. I am informed that this morning we have got in Monte Video seven fresh subscribers, and that at £12 is a nice little sum. Well, I will now proceed to say a few words on the Austrian business. In July at the meeting in Cannon-street we told you that we should make that business a paying one if you would give us some more money to do so. I have here at this moment the latest return for Austria. The manager writes: "We have now a surplus of receipts over maintenance of about 10,000 florins"—that means £800 in round numbers, I believe. But we have still a certain number of gentlemen out there waiting for telephones to be put up, and each telephone that we put up will be a source of revenue. Of course you cannot put up a wire and erect a telephone to join these various subscribers without money, and as a means of getting that money to convert those gentlemen into a source of revenue, the Board propose to issue some debentures of the Austrian Telegraph Company, and very possibly offer them to some of the shareholders. I should tell you that each day that I know anything about the Austrian Company strengthens my belief that we have a very valuable property there. A concession in nine towns which have—I think I am near the mark in saying—nine of them under 30,000 inhabitants, and some ranging up to 300,000, is a very valuable concession, and in course of time I look to receive a very large income from that Austrian business.

The resolutions were then put to the meeting and confirmed, which terminated the proceedings.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. JAN. 7.		BUSINESS DONE WEEK ENDING JAN. 7. Highest.	Lowest.
Anglo-American	30,	31	31¼	30
Do. Preferred	54,	55	55¼	54¾
Do. Deferred	7½,	8	8 3-16	7⅞
Brazilian Submarine	10¾,	11	11	10 13-16
Cuba	11,	11½	—	—
Do. Preference	17,	18	—	—
Direct Spanish	3,	3½	—	—
Do. Preference	13½,	13¾	13½	—
Direct United States Cable	9⅜,	9½	9⅝	9½
Eastern Telegraph	11¾,	12	12	11¾
Do. 6 per Cent. Preference	13⅜,	14½	14¼	13 15-16
Do. 5 per Cent. Debentures, 1899	104,	107	—	—
Eastern Extension	12½,	12⅝	12⅝	12 5-16
German Union	9⅜,	10½	—	—
Globe Telegraph and Trust	6¼,	7	7⅛	6 13-16
Do. Preference	12½,	12⅝	12 11-16	12½
Great Northern	14½,	14⅞	14½	—
Indo-European	32,	33	—	—
Reuter's	7½,	7⅞	—	—
Submarine	175,	180	179½	177
West India and Panama	⅜,	1	—	—
Do. 1st Preference	7½,	7⅞	—	—
Western Brazilian	6⅜,	6½	6 13-16	6⅝
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅜,	½	7-16	—
Oriental	⅜,	⅝	—	—
United Telephone	11½,	12	11⅝	11 13-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	—	—
Do. (fully paid)	3½,	4	3 11-16	3 9-16
Hammond Light (£3 15s. paid)	¾,	1	¾	¾
Swan	¼,	½	—	—
Maxim-Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	35,	36	35	—
India Rubber, Gutta Percha, and Telegraph Works	22,	23	22½	22½

TRAFFIC RECEIPTS FOR DECEMBER, 1884.

COMPANIES.	Dec., 1884.	Dec., 1883.	Increase.	Decrease.
Cuba Submarine	2,500	2,559	—	59
Direct Spanish Telegraph	—	—	—	—
Eastern Extension	41,426	35,335	6,091	—
Eastern Telegraph	53,036	49,181	3,855	—
Great Northern	19,000	—	—	—
West Coast of America	3,750	—	—	—
Direct United States	—	—	—	—
Submarine	—	—	—	—

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NOTES.

TELEGRAMS FOR CEYLON.—The Post Office circular of 13th January states that the cable between India and Ceylon is interrupted.

NEW YEAR'S WISHES.—One of our contemporaries in the gas interest wished its readers "More Light." We re-echo the wish in a slightly extended form—"More and Purer Light."

SOCIETE GENERALE DES TELEPHONES.—The paid-up 375f. (£15) shares in this company were quoted at 390f. on 5th January, but fell to par on 12th January, and are now down to 370.

ANNUAIRE DU BUREAU DES LONGITUDES.—The edition of this publication for the present year contains, for the first time, tables of electric units, &c., in constant use by electricians.

THE TELEPHONE IN MEXICO.—On 1st November, 1884, there were 560 subscribers to the Telephone Exchange of Mexico, which city contains 250,000 inhabitants. At Guadalajara the Mexican Company now numbers 158 subscribers.

THE TELEGRAPH IN PERSIA.—Referring to our note of last week, the *Standard's* Teheran correspondent telegraphs that the Russians are already laying the line from Askabad to Merv, but that there had been a heavy fall of snow throughout Persia.

THE INVENTIONS EXHIBITION.—The Council of the Society of Arts announce that, under the Howard Trust, they will award gold medals for best exhibits in certain classes, amongst which is one in class 72, group 13, "Electricity"—distribution and utilisation of power.

ELECTRIC LIGHT IN PARIS.—The electric light is to be used during the construction of the new buildings to be erected at the Saint-Lazare or Western Terminus, Paris; and it is thought likely that arrangements will be made for electrically lighting them when complete.

THE FOUNTAINS AT THE HEALTHERIES.—*Electricité* of last Saturday publishes a good representation of the luminous fountains at the recent Health Exhibition, of course minus the beautiful and ever-varying hues, which constituted one of the chief features of Sir Francis Bolton's fairy creation.

ALTERNATE-CURRENT MOTORS.—The conclusions arrived at by M. E. Hospitalier in an article on this subject in *L'Electricien* are that alternate currents may produce work like continuous currents, whether at uniform or variable speeds; but, in both cases, alternate currents are less convenient and economical than continuous currents.

ELECTRO-TECHNOLOGY.—A course of fifteen lectures, interspersed with practical demonstrations, will be given at the University College, London, by Dr. J. A. Fleming, on "Modern Application of Electricity in the Arts." The introductory lecture is fixed for February 6; and the lectures will be continued every Friday at 4 p.m.

ELECTRIC LIGHT FOR BURNTISLAND HARBOUR.—At the monthly meeting of the Burntisland Harbour Board the harbour engineer, Mr. R. Henderson, brought up a report on lighting the harbour by the electric light, with motive power furnished by a Crossley gas engine. The report was favourably considered, and was handed over to a committee.

LONG-DISTANCE TELEPHONY.—The French Minister of Posts and Telegraphs, M. Cochery, lately assisted at some experiments in telephoning, on the Van Rysselberghe system, over the telegraph wires between Rouen and Havre. These experiments were not so satisfactory as those in Belgium and Portugal, probably because the distance was too great.

ELECTRIC LIGHT AT HAMMERSMITH.—The West Middlesex Electric Lighting Company announces that it is prepared to receive proposals for the execution of the first section of its works authorised by the Fulham District Order, 1884. Plans and particulars are to be obtained from the secretary, Mr. W. G. Colley, Caxton House, The Grove, Hammersmith.

PERSONAL.—The Administrative Council of the Societé de Crédit Mobilier has been strengthened by the addition of M. Duchâteau, who took a large part in the composition and management of the Societé Générale des Téléphones, and also in the first telephone lines of Italy and Belgium, besides turning his attention to electric lighting and the electrical transmission of power.

ELECTRICAL ENGINEERING PRACTICE.—The course of instruction at the Engineering School, University College, Nottingham, includes practical work in pattern making, moulding, fitting, turning, erecting, &c., as well as the College Lectures. Students are allowed to construct lathes and engines for themselves; and electrical engineering students are employed in the construction of dynamos.

PROGRESS OF ELECTRIC LIGHTING IN PARIS.—This, unfortunately, is in the wrong direction; *mais nous verrons bien.* The Jablochkoff candles have disappeared from the Avenue de l'Opéra; and one or two theatres that were electrically lighted have ceased to be so—for the time being. The Hippodrome, however, and most of the large drapers' shops—*magazins de nouveautés*—stick to the pure light.

THE EXCHANGE TELEGRAPH COMPANY AND THE STOCK EXCHANGE.—The question as to the value of the tape system in Stock Exchange transactions is still being discussed in the money columns of our contemporaries. We understand that a meeting was arranged to take place yesterday (Friday) between the directors of the Exchange Telegraph Company and the managers of the Stock Exchange.

ELECTRIC LIGHT IN CORN MILLS.—Messrs. Bowyer and Priestley, Offord Cluny, Hunts, who have adopted all the latest improvements for grinding corn and dressing the flour, have, for nearly two years past, lighted their large corn mill with incandescent lamps, the dynamo being driven by the mill engine. This change from candles and oil lamps to a better and above all safer light has given the greatest satisfaction to all concerned.

ELECTRIC LIGHT AS A BEACON.—In the dark days of December two students staying with the Bishop of Durham at Auckland Castle started off in the after part of the day for a walk to high ground about four miles distant. Darkness overtook them, and, being strangers to the district, they were quite at a loss to find their way back, until the arc lamp at the top of Duff and Rowntree's premises shone out, and by its assistance they were able to find their way home easily.

PHOSPHOR BRONZE WIRE.—With reference to our note on 3rd January, with reference to the breaking of telephone wires in a storm at Brussels, we learn that the wire so favourably reported on by M. Emile Bède, as resisting the violence of the gale and remaining unchanged by climatic influences, is of *bronze-phosphoreux*, made at the Fonderie d'Anderlecht, Brussels, by M. Montéfiore-Lévi, and of which the agents for the United Kingdom are the Western Electric Company, of Moorgate-street, E.C.

FRENCH EDISON COMPANY.—The Société Electrique Edison has lately installed 100 lamps, worked by a high-speed Gwynne

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motor, for the Crédit Foncier, and also 100 additional lamps at the Hôtel de Ville. In the provinces, 50 lamps have been put up at the Poudrerie Nationale de St. Ponce, in the Ardennes; 25 lamps at the dye works of Champyron et Chavanne frères, St. Etienne; 50 lamps at Lyons, *chez* Chavaut; and 200 lamps at the paper mills of Outhenin-Chalandre, Geneuille, Doubs.

SILVER VOLTMETER.—To measure an electric current, the cathode is a platinum cup, and the anode a silver leaf enclosed in filtering paper. The anode is immersed in a solution of nitrate of silver contained in the cup; and an ampere deposits 4 grammes (62 troy grains) of silver per hour. It therefore suffices to allow the current to pass through the voltmeter for half an hour or an hour, in order to obtain a deposit of silver, which may be weighed correctly by an analytical chemist's balance.—*Electricité.*

LECTURES ON ELECTRICITY IN PARIS.—For some time past, the question has been under consideration of adding a course of lectures on electricity to the instruction given at the Ecole Centrale des Arts et Manufactures. Among the electricians capable of filling the new chair of electricity, the names have been mentioned of M. Hospitalier, Professor at the Ecole Municipale de Physique et de Chimie; M. Monnier, laboratory director of the Association pour l'étude de l'Electricité; and M. Géraldy, late Ingénieur des Ponts et Chaussées.

ELECTRIC LIGHT AT THE BRIGHTON PAVILION.—On Saturday evening the Brighton Town Council threw open the Pavilion to public inspection, when about 700 persons visited the apartments to view the electric light. The illumination was maintained with great steadiness, and general satisfaction was expressed. The pure light also showed off to great advantage the fresh decorations in the north drawing room. In the evening the corporation organist, Mr. Alfred King, gave a recital in the music room on the restored chamber organ.

THE LIGHTING OF THE CITY.—Some time ago we mentioned that the Hammond Company had been selected to light some of the City streets. This information is now confirmed, and the Commissioners of Sewers have accepted the contract for the lighting of Old Broad-street, front of Mansion House, Royal Exchange-buildings, Bartholomew-lane, Lothbury, Princes-street, Lombard-street, Birchin-lane, Bishopsgate-street Within, Throgmorton-street, Threadneedle-street, and Gracechurch-street. The decision was arrived at with closed doors.

ELECTRIC LIGHTING OF THE "EXMOUTH."—The following recommendation of the "Exmouth" Training Ship Committee was adopted by the Metropolitan Asylums Board:—"That the committee be authorised to invite schemes and tenders for lighting the 'Exmouth' by electricity; and, when such schemes and tenders are received, to consult a competent engineer with the view of obtaining his advice as to what additional boiler power it will be desirable to provide for this and other purposes connected with the administration of the ship."

ELECTRICITY ON BOARD SHIP.—It is stated that exhaustive experiments, with a view of determining the relative cost of oil, gas, and electricity for lighting ships of war, are about to be instituted by the Admiralty, on board the "Colossus," at Portsmouth. We are of opinion that such experiments as these are utterly out of place, and lead to a large expenditure of money without any adequate return. The question is not so much whether oil, gas, or electricity is the cheapest, but which is best for the purpose in view—that is to say, for purposes of warfare

ELECTRICALLY-LIGHTED SUBWAY FOR THE CITY.—On Tuesday last the Commissioners of Sewers had under consideration the proposal of Mr. H. H. Bridgman for the construction of a system of subways for the relief of the passenger traffic in the neighbourhood of the Mansion House. The scheme consists of a central subterranean chamber, surmounted by a skylight and four radiating subways, lined with glazed bricks. It was stated that a proposal had been received for electrically lighting the subways. The matter was referred to the Streets Committee.

ELECTRICAL ENTERPRISE IN FRANCE—*Electricité*, which has dropped the definite article beginning its former title, says that the year just past has not been among the most favourable to the development of electrical applications in France, most of the companies formed for working the discoveries of the new science having felt the rebound of the commercial crisis. Thus, stagnation in electrical affairs has been general; and the movement which seemed to be considerable after the first electrical exhibition, held at Paris in 1881, has produced but indifferent results.

JABLOCHKOFF AND GENERAL ELECTRICITY COMPANY.—This company has been registered, with a nominal capital of £20,000, divided into 200 shares of £100 each, for the purpose of purchasing the whole of the Jablochkoff patents, with the stock and goodwill as a going concern of the late Jablochkoff Electric Light and Power Company. Sufficient capital has been subscribed privately, and the purchase contract has been confirmed by the Court of Chancery. Mr. Francis R. Reeves has been appointed secretary and manager of the new company, whose registered offices and works are at No. 36, Albert Embankment, Lambeth, London, S.E.

ELECTRIC LIGHTING IN THE ISLE OF BUTE.—Mount Stuart House, the new family mansion which has been built by the Marquis of Bute, is to be lighted throughout by electricity, and cables for about 400 incandescent lamps are already fixed. Mr. Massey, of Thyford, having charge of all the arrangements. The cost of the building is put at £700,000 by one authority, and £750,000 by another; but it will probably reach nearly a million before the work is completed. Lord and Lady Bute, the family, and servants have been living in parts of the house for some time, and they use a large number of lights daily; so do the builders, who are working early and late to get the place finished.

ELECTRIC RAILWAY CONSOLIDATION IN NEW YORK.—Sir William Thomson has been invited to occupy the post of consulting electrician, and has agreed to do so provided he is not required to leave England. Some of the talk is rather tall as to the saving of coal, &c.; but the principal feature, viz., the absence of smoke and steam on the elevated railways seems to have been overlooked. It has been suggested that each competitor shall have one day's trial in drawing a train; but, if this be carried out, the result of the trials will not be worth much, as the best machine might be out of adjustment the first day and the worst happen to run all right. To have any real value each separate trial should extend over a reasonable period.

INTERESTING FIND BY THE HAMMOND COMPANY.—On Tuesday evening, while the electricians employed by the Hammond Electric Light Company were engaged in the underground cellars of the Mansion House, fitting up the wires for the electric light to be used in the Egyptian Hall and saloon, a skull and a number of human bones, together with those of some animal, were found under a flagstone which it had been

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necessary to take up. The remains were discovered lying 2ft. below the surface, and, in the opinion of the authorities, they must have come from the adjoining burial ground of St. Stephen's, Walbrook, long since fallen into disuse, as their condition showed that they had been a considerable time underground.

PUBLIC TELEPHONE RATES IN FRANCE.—A decree of the President of the French Republic, signed on 31st December, 1884, by M. Jules Grévy, and countersigned by M. Cochery, Post and Telegraph Minister, fixes the rates to be levied for telephonic communication between the public at a "call" office and a subscriber or a non-subscriber at another "call" office. The rate for five minutes' conversation in Paris is 50 centimes (5d.), and in the other towns of France, Algiers, or Tunis, half that amount. The rate for five minutes' conversation between two separate towns is fixed at 1 franc (10d). for any distance less than 100 kilometres or 62 miles. This charge may be reduced to one-half when the two towns have been classed by the Post and Telegraph Minister as forming part of one and the same telephone group.

ELECTRIC LIGHTING AT HATCHETT'S.—The celebrated hostelry so long known as the White Horse Cellar has been entirely rebuilt, and will be reopened to the public on Monday next. With the sole exception of the bed rooms and private sitting rooms, which are to be lighted by time-honoured wax candles, the whole of the illumination will be effected by Edison electric lamps, variously applied. The current is supplied by the latest form of Edison dynamo machines, driven by two Otto gas engines of 12 horse-power nominal, the whole plant being in duplicate, to provide against accident. Messrs. Verity and Sons have put up the plant, the engine room having been specially constructed by Mr. John Waldram, C.E., superintendent of the entire works. The lighting of the dining room will be from the tables alone.

THE TELEPHONE COMPANIES.—Commenting on our remarks in last week's summary for 1884, relating to the defects of the telephone system, the *Pall Mall Gazette* says:—"If *The Electrician* had its way in the framing of a policy with regard to the telephonic interests of the country it would suggest the compulsory purchase of private interests by the State, the extension of underground wires, the lowering of rates, and the opening of every telegraph office as a telephone office." "But," continues the *Pall Mall*, "having had a lesson of the dog-in-the-manger policy which results from State monopoly in the telegraphs, remembering, too, that invention flourishes best when fanned by keen competition, and seeing that the telephone is in its infancy, most people will probably prefer that commercial freedom and a healthy competition should rule the roast longer yet." We fancy that "most people" here referred to does not include the telephone companies themselves, nor their customers, nor the public at large; but stands chiefly for newspaper theorists. Next week, however, we hope to be able to argue the point more fully.

NEW SINGLE-LIQUID BATTERY.—In the new battery of Buchin, Tricoche et Cie, a rod of amalgamated zinc forms the positive, and several rods of carbon the negative pole, the liquid being a weak acid or basic solution, such as that of sulphuric acid, of a bisulphate or acid sulphate, of hydrochlorate of ammonia, or of sea salt. The carbon is said to be so modified all through its substance during manufacture that hydrogen cannot accumulate on its surface; but the gas is obliged to pass off as generated, thus avoiding polarisation. This new battery, the E.M.F. of which is 1·15 volt, is claimed to be capable of working for an almost indefinite period, so long as the liquid lasts, to occupy little space, to be of easy management, and to be cheap, both in first cost and maintenance. It has, however, a high internal resistance when required to give out a large quantity of current, as in the case of electric lighting. This is attributed by the inventors to the fact that the hydrogen, on being disengaged, in raising up the carbons forms a layer of gas which opposes the current. They hope, however, to be able in time to counteract this disadvantageous action.

CARBONS FOR ELECTRIC ARC LIGHTS.—Carbons for arc lights may be made, says a well informed writer, by thoroughly incorporating a mixture of finely divided carbonaceous materials, such as the purer forms of coke, or gas retort carbon, with some liquid substance, such as oil, tar, or sugar syrup, that, when subjected to a high temperature, is capable of being carbonised. The finely divided ingredients are thoroughly mixed and made into a stiff paste with the carbonisable liquid, and then forced by heavy hydraulic pressure through circular apertures in plates. The continuous cylindrical rods thus obtained are cut into suitable lengths, carefully dried, and then heated to incandescence in ovens while out of contact with air. By this process the carbonisable liquids are reduced to a carbon, which thoroughly binds together the various ingredients. Experience has shown that the higher the temperature and the greater the length of time during which the carbons are subjected to the baking process, the greater their hardness and the higher their electrical conductivity. In order to ensure freedom from slight porosity, in most cases the carbons are subjected to a re-baking. After removal from the oven they are soaked in strong syrup, and again placed in the oven and heated to incandescence as before.

LONG-DISTANCE TELEPHONY.—In commenting on the three systems of long-distance telephony, the *Bulletin Internationale des Téléphones* says that M. Van Rysselberghe's plan utilises existing telegraph wires, and permits of the simultaneous transmission of telephonic and telegraphic messages, while diminishing the speed of the latter. That inventor has succeeded in diminishing the effect of induction; but he has not entirely suppressed it, while, however, preserving a sufficiently clear perception of the oral message. On the other hand he cannot telephone to advantage over greater distances than 80 kilometres, or 50 miles. The Herz method is also founded on the use of telegraph wires, and ostensibly neutralises induction; but the transmission of speech is effected with difficulty when the wires are being used for telegraphing. If it may be applied to long distances, conversations are not distinct in such a case. As to the third system, of double wire twisted, perhaps more scientific than the others, and the only one used in England and America, where it transmits for distances of 125 kilometres or nearly 80 miles, a special line is required, entailing greater expense; but there is every interest in keeping wires exclusively for telephoning. Our contemporary, therefore, very properly gives the palm to the last-named system, as that which best neutralises induction and affords a good exchange of communications.

ATTRACTION OF BODIES IN SOLUTION.—M. J. Thoulet is convinced that when a solid body is immersed in a salt solution, an attraction independent of chemical action is set up. The following is one of the experiments which have led him to this conclusion:—Grains of quartz, glass and marble, screened so that the diameter of the coarse particles is 0·9mm., and that of the fine 0·15mm., were immersed in iodine solution contained in three long and narrow tubes. Equilibrium was

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established by the addition of water; the tubes were hermetically sealed and then placed in a vessel filled with water, for avoiding rapid variations of temperature. Supposing the grains to be spherical, the volumes vary as the cubes of the radii, while their surfaces vary as the squares of the radii; for an equal volume the surface would, therefore, be proportionally greater for a small than for a large grain. If the attraction exerted by the immersed solid on the body in solution be effected in direct ratio from the surface of the immersed solid, it will be impossible to float the large and small grains simultaneously. If the large float, the small behave as if they were heavier—that is to say, they fall to the bottom. This is proved by experience, except in the case of marble, all the grains of which, according to the density of the liquid, rise or fall at the same time, because, as these grains are porous, their surfaces are nearly proportional to their volumes.

Western Electric Company.—The specialty of this company is the manufacture of all apparatus pertaining to the telephone. Being sole manufacturers to the American Bell Telephone Company, and, through its Continental branch, to the International Bell Telephone Company, its instruments are in great demand. Through its London warehouse—in Moorgate-street, E.C.—it is enabled to meet promptly large demands for magneto bells, switch-boards, annunciator drops, and all other accessories of telephone exchange apparatus. Perhaps the most important improvement in telephone service during the past year has been effected at Liverpool by the introduction of the "multiple switch-board," which has been much approved by the Exchange subscribers and the directors of the company, owing to the great increase of speed in working, with corresponding reduction in the number of operators. In no other Exchange in England, probably, are 1,000 subscribers worked by 10 operators, with an average time for connections of 14 seconds. Improvements effected in the multiple board during the past year still further increase the speed of working and reduce the number of operators required. This company has lately introduced a new magneto bell, now turned out in large numbers from the Antwerp factory; and Patterson's patent anti-induction cable has been in great demand among trans-Atlantic companies, while last year some miles of it were laid down in Melbourne with the best results.

Failure of an Electric Bell.—On Saturday night the Great Northern down express from London to Manchester, which is timed to leave King's-cross at 6:15 and to reach Manchester at 10:45, had an extraordinary escape near East Retford. At Ordsall-lane is an ordinary level crossing, where the signal of approaching trains is given by electric bell from a signal box about half a mile distant. On Saturday night the attendant at this crossing received the signal for an up goods train, which he duly passed. At this moment a cart containing five men, who lived at Morton-grange, and who had been attending the Retford Market, was waiting to cross the line, and as soon as the train had passed, the attendant, having received no signal of an approaching train, opened the gates and called to the man in the cart to cross. The horse had just placed its feet on the rails when the express was seen under the bridge on the Great North-road, only 300 yards distant. The attendant shouted to the driver and seized one of the gates to throw it back, but as he was doing so, the express dashed past and smashed one of the gates into splinters. Strange to say the man was not hurt. The express pulled up at Retford, where on examination it was found that one of the lamps was gone, and this was subsequently picked up in a field adjoining the crossing. One of the vacuum brake pipes was also smashed. It was subsequently discovered that the electric bell at the signal station of the level crossing was out of order, and thus had not responded to the signal given by the signalman. Had the train been two or three seconds later the results would probably have been very serious.

Large or Small Dynamos?—In a work on the electrical transmission of power, M. Marcel Deprez and M. Japing state that a great many problems connected with this subject may be solved with the machines already constructed and the means actually at command, and also that the future is to large machines. Commenting on this, the *Bulletin International des Téléphones* observes that electric lighting experiments in England and Austria with alternate-current machines do not appear to have settled the question; Edison with his continuous-current machines does not seem to have exceeded 40 or 50 horse-power, a long way off 200 horse-power; and M. Marcel Deprez's experiments at Creil have special interest in this connection. Our contemporary, however, asks if, in every respect, large machines give comparatively better results than small. It is intended that the generating machines at Creil shall weigh from 35 to 40 tons for a current of 7,500 volts and 20 amperes, equal to 200 horse-power at starting. The receiving machines at Paris will weigh from 7 to 8 tons, and communicate to the shaft an available work of 30 to 35 horse-power, whence it follows that the weight per horse-power will be about 175 kilograms (3½cwt.) for the generator, and 200 kilograms (nearly 4cwt.) for the receivers, under the most favourable conditions. Now, in the present machines, such as the Gramme, for instance, the weight per horse-power does not attain 40 or 80 kilograms (rather over 7½ or 15 cwt.), according as they are used as generators or receivers. Therefore, the mean weight of matter per horse-power in large electrical machines will greatly exceed that of small machines. Here is a contradiction not generally met with. But, adds the *Bulletin*, this is not the first time that electricity quits beaten paths; and such small details will be no bar to ultimate success.

National Telephone Company.—We have been favoured by Mr. A. R. Bennett, general manager for the north of England and Scotland to the National Telephone Company (Limited), with a series of the new stamps adopted by the company for the payment of messages from non-subscribers throughout their districts; and we are glad to learn that the receipts for these "fee" messages (as they are called) from non-subscribers using the call offices in Edinburgh, Dundee, and Aberdeen, are already considerable. The head on the stamp is that of Colonel R. Raynsford Jackson, the chairman of the National Telephone Company, and the system is as follows:—In each call office will be found a pad of forms divided into oblong spaces, numbered from one to fifty. A subscriber to the company's exchange system, being entitled to use the call office gratis, will be required to sign his name in the next vacant space whenever he avails himself of the privilege; but a non-subscriber will be required to attach telephone stamps to the value of his conversation—not the intrinsic value, of course—in the next vacant space. The tariff being (for conversations with subscribers situated within six miles of the Chief Exchange of any town worked by the National Telephone Company) 3d. for every three minutes, and 1d. for each additional minute, a conversation lasting three minutes would require the attachment of a 3d. stamp to the form, one lasting four minutes a 3d. and a 1d., one lasting six minutes two 3d., &c. When the fifty oblong spaces have been filled with stamps or signature, the form is removed by the attendant, and a fresh one exposed.

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The forms constitute a simple method of checking the company's receipts, in order to arrive at the amount of the Government tax of 10 per cent. The present series of stamps consist of 1d., 3d., 6d., and 1s., but a 4d. and a ½d. will shortly be added, and the stamps are on sale at the company's head office and also at all the call offices. The system was invented and the stamps were designed by Mr. A. R. Bennett, the company's general manager for Scotland and the North of England.

MAGNETIC OBSERVATIONS AT KEW.—The report of the Kew Committee for the year ending 31st October, 1884, contains the tabulated results of the deflection and vibration observations made at Kew between October, 1883, and September, 1884. They were all made by Mr. T. W. Baker with the collimator magnet marked K C 1, and the Kew 9in. unifilar magnetometer by Jones. The declination observations were also made with the same magnetometer, collimator magnets 101 B and N E being employed for the purpose. The dip observations were made with dip-circle barrow No. 33, the needles 1 and 2, 3½in. in length, only being used. The results of the deflection and vibration observations give the values of the horizontal force, which, being combined with the dip observations, furnish the vertical and total forces. They are expressed in both English and metrical scales—the unit in the first being one foot, one second of mean solar time, and one grain; and in the other one millimetre, one second of time, and one milligramme, the factor for reducing the English to metric values being 0·46108. By request, the corresponding values in C.-G.-S. measure are also given. The value of log $\pi^2 K$ employed in the reduction is 1·64365 at temperature 60°F. The induction coefficient μ is 0·000194. The correction of the magnetic power for temperature t_0 to an adopted standard temperature of 35° F. is $0{\cdot}0001194\,(t_0 - 35) + 0{\cdot}000{,}000{,}213\,(t_0 - 35)^2$. The true distances between the centres of the deflecting and deflected magnets, when the former is placed at the divisions of the deflection-bar marked 1·0 foot and 1·3 feet, are 1·000075 feet and 1·300097 feet respectively. The times of vibration are each derived from the mean of 12 or 14 observations of the time occupied by the magnet in making 100 vibrations, corrections being subsequently applied for the torsion-force of the suspension-thread. No corrections were made for rate of chronometer or arc of vibration, these being always very small. The value of the constant P, employed in the formula of reduction $\frac{m}{X} = \frac{m'}{X'}\left(1 - \frac{P}{r_0^2}\right)$, is −0·00129. In each observation of absolute declination the instrumental readings have been referred to marks made upon the stone obelisk erected 1,250 feet north of the Observatory as a meridian mark, the orientation of which, with respect to the magnetometer, was determined by the late Mr. Welsh, and has since been carefully verified.

ELECTRICITY FOR THE ELEVATED ROADS, NEW YORK.—Professor Moses G. Farmer has furnished Mr. Cyrus W. Field with an estimate of the cost of operating the Second Avenue Elevated Railroad of this city by electricity, as compared with steam. He says:—I assume that a stationary plant can be erected somewhere near the middle of the line, not far from Sixty-third-street, this plant to consist of one or more stationary steam engines of the best type, capable of developing one horse-power by the combustion of 1¾lb. of coal per hour per horse-power, by the use of such coal as does not cost over 2 dols. 50 cents per ton of 2,240lb. I assume that there are in use on this line twenty locomotives of 110 horse-power each at the busiest hour of the day, and that each locomotive consumes—per horse-power per hour—5lb. of coal that costs 4 dols. per ton of 2,240lb. I assume that the rails now in use are of steel, and weigh 70lb. per yard, and that a central steel rail of 70lb. per yard will be laid for the purpose of conveying the electric current to the motors. I assume that one mile of such steel rail will offer about 1-20 of an ohm resistance, and that the aggregate internal resistance of the dynamos concerned in producing the current will not exceed 1-200 of an ohm. I assume that from this central station sufficient current will be supplied to both tracks to energise at the same instant all of the twenty electric locomotives, no matter on what part of the tracks these motors may be situate. I assume that 1 horse-power is the equivalent of 746 ampere-volts, and that 20 by 110 by 746 = 1,641,200 ampere-volts, in the aggregate, reach these motors. I assume that such dynamos can be constructed as shall convert 90 per cent. of the mechanical power applied to them into current electricity, and I also assume that such electric motors can be constructed and used as shall convert 90 per cent. of the electricity that they receive into power used to draw the trains that are attached to them. I assume the Second Avenue Railroad to be six and a half miles in length. With these assumptions, I have calculated the following tables:—

TABLE I.

Volts.	Present power.	Future power.
500	2,200	3,369
1,000	2,200	2,879
1,500	2,200	2,787
2,000	2,200	2,757

TABLE II.

Volts.	Present coal.	Future coal.	Saving per hour.
500	11,000	5,895	5,104
1,000	11,000	5,039	5,961
1,500	11,000	4,889	6,111
2,960	11,000	4,825	6,175

TABLE III.

Volts.	Present cost.	Future cost.	Saving per hour.
500	$19.65	$6.58	$13.07
1,000	19.65	5.62	14.03
1,500	19.65	5.46	14.19
2,000	19.65	5.38	14.27

Table 1, column one, contains the electromotive force developed by dynamos at the central station; column two contains the horse-power required by the 20 locomotives; column three contains the horse-power that must be used at the central station in order to deliver at the electric locomotives the equivalent of 2,200 horse-power. Table 2, column one, contains the electromotive force, as in the first table; column two contains the hourly consumption of coal by the 20 locomotives now in use—5lb. per hour per horse-power; column three contains the amount of coal consumed by the stationary engine that develops 1 horse-power by the combustion of 1¾lb. of coal per hour; column four shows the saving in lbs. of coal per hour made by substituting the better engine, the dynamo, the electric motor, and the rail circuit. Table 3 shows the hourly saving in dollars and cents by the substitution of electricity thus applied for the coal now used in the locomotives. It will be seen from this last table that the lower and safer electromotive force of 500 volts is only about 9 per cent. more expensive than the four times as great 2,000 volts, and about 7 per cent. more expensive than 1,000 volts. I must reserve for another letter my conclusions regarding what would be the saving resulting from the use of electricity on the Third Avenue line, as I wish to obtain some further information as to frequency of trains, &c.

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WILLIAM GARNETT.

GARNETT, WILLIAM; born at Portsea in December, 1850. In January, 1863, he entered the City of London School, and was at first under the mastership of Mr. Thos. Hall, B.A., who did very much towards the development of scientific teaching in that school. In the May examination of 1866 he obtained the first Royal Exhibition, tenable at the Royal School of Mines and College of Chemistry, and during the winter session he studied under Dr. Frankland and Professor Tyndall, but in the following year resigned the exhibition and returned to the City of London School. In April, 1869, he gained the Exhibition for Natural Science at St. John's College, Cambridge, and in July of the same year the Beaufoy Mathematical Scholarship at the City of London School, and commenced residence at St. John's College in October. The following summer he was first in the competition for Sir Jas. Whitworth's Scholarship for Mechanical Engineering, and in 1871 was elected Foundation Scholar at St. John's College. In January, 1873, he took his degree as Fifth Wrangler (bracketted), and shortly afterwards, on the opening of the Cavendish Laboratory, he was appointed Demonstrator in Experimental Physics by Professor Clerk Maxwell. In November, 1874, he was elected Fellow of St. John's College, and retained his fellowship till his marriage in 1879. In October, 1876, he commenced to give public lectures in the Cavendish Laboratory, and continued to lecture there upon mechanics, heat, magnetism, and electricity, until Easter, 1880. In April, 1879, he was appointed by the Senate Examiner in Natural Philosophy in the University of London. Professor Clerk Maxwell died in November, 1879, and in the following month Lord Rayleigh accepted the Professorship of Experimental Physics. Mr. Garnett remained in the Cavendish Laboratory until Easter, 1880, when he declined to be reappointed. Shortly afterwards he was appointed Lecturer on Physics at St. John's College. In 1879, 1880, and 1881, he was one of the Examiners in the Natural Sciences Tripos. In April, 1882, the Committee of University College, Nottingham, invited him to accept the Professorship of Mathematics, Physics, and Mechanics.

Shortly afterwards he was appointed Electrician to the Corporation of Nottingham. He commenced work at Nottingham in October of the same year. During the following summer he organised a system of technical education in connection with the mechanical department of the College, and fitted up a complete set of engineering workshops, which were very largely attended by the artisan classes during last session. These workshops were formally opened by Sir Frederick Bramwell, F.R.S., on the 24th January last. Besides a complete plant of engineers' tools, the mechanical schools are furnished with dynamos and other appliances for students in electrical engineering, and the electric lighting of the Free Library by the Ferranti dynamo has been very successful. In November, 1883, Professor Garnett was appointed Principal and Professor of Mathematics in the Durham College of Science, Newcastle-on-Tyne, with the understanding that his full duties would not commence until the following October. He is now giving special attention to the development of technical education in the Tyneside district, and a scheme is on foot for the erection of a central college in which a University education will be provided for day students, while workshop and laboratory instruction, as well as theoretical training on scientific principles, will be given to those employed in the chief manufacturing industries of the locality. As the college represents the Science Faculty of the University of Durham, students passing successfully through its curriculum will be able to take degrees in science from the University.

Professor Garnett's treatise on Elementary Dynamics is now the acknowledged text book on that subject for candidates for the Mathematical Tripos. He is also author of an elementary treatise on Heat; a very Elementary Mechanics for the use of Higher Grade Schools, published by the S.P.C.K. at 4d.; a "Book of Trigonometry," intended specially for the use of candidates for the Cambridge Local Examination; and, with Professor Lewis Campbell, was joint author of the "Life of James Clerk Maxwell." Professor Garnett edited "Maxwell's Elementary Treatise on Electricity," the manuscript of which was left unfinished by the author. His lecture notes on Electricity, printed for the use of his students at Nottingham, occupy more than 100 pages, the first half of which formed the basis of the articles on elementary electricity which have from time to time appeared in the columns of *The Electrician*. His lecture notes on Heat and Astronomy, similarly prepared under the auspices of the Cambridge Syndicate for the Extension of University Teaching, form convenient summaries for students wishing to *revise* the subjects.

Garnett's Elementary Dynamics.

An opportunity is afforded us to call attention to a work which, like "Cumming's Electricity," is at once good, and insufficiently known. With regard to the former work, we have been surprised to find many men whose names stand high in the ranks of the electrical world totally unacquainted with the book; and during a somewhat long and chequered experience among educationalists the ignorance of many schoolmasters as to the good books published has seemed to us a bad sign. It may be said that Cambridge is the centre of mathematical activity, without fear of contradiction, but many books are exclusively used at Cambridge that do not seem to take their proper position outside the bounds of the University. In 1875, when Professor Garnet's book on "Elementary Dynamics" was issued, the present writer was editor of the *Journal of Education*, and therefore had good opportunities of hearing the opinions of those best qualified as to the promise shown in such a work. Almost without exception the criticisms were very favourable, and when qualified it was only to suggest the book to follow a more elementary one. The work commends itself, we think, to electrical engineers in many respects, not the least of which is the manner in which the question of "units" is discussed Our vulgar education makes us acquainted with English units. we use them in the shop and in the field; but our more refined education makes us acquainted with more refined methods, and usually a system of mental translation takes place whenever one of the more modern limits is mentioned in measurement. In conclusion, we may say that the engineering student, whether he desires to specially follow the civil, mechanical, hydraulic, or electrical branch of the profession, will find the fundamental laws of "Mechanics" admirably set forth in this little work.

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ALTERNATING CURRENTS. — SELF-INDUCTION. GRAPHIC REPRESENTATION.

BY THOMAS H. BLAKESLEY, M.A.

It is often taken for granted that the simple form of Ohm's law—total E.M.F. ÷ total resistance = total current, is true for alternating currents. That is to say, the E.M.F. employed in the formula is taken to be the sum of the *impressed* E.M.F.'s alone. That there are causes which modify the value of the current as deduced from this simple equation, such as mutual or self-induction, or the action of condensers, is often acknowledged in text books, and the values and laws of variation of the current correctly stated for certain cases of instantaneous contact and breaking of circuit. But the effect of an alternating E.M.F. upon a circuit affected by self-induction, mutual induction, and condensing action, has not been, as far as I know, put into a tangible working form.* I propose to deal with the case where the impressed E.M.F. is subject to simple harmonic variation—that is to say, the sort of variation which takes place in the apparent distance of a satellite from its primary as seen by an eye situated in the plane of revolution, and at an indefinitely great distance from the orbit. The form of the law is simply $x = b \sin\left(\frac{\pi}{T}\overline{t - t'}\right)$ where t is the symbol for time, t' being the value at the particular epoch when x is zero, x representing the magnitude subject to the variation under consideration. Since the sine of no angle can exceed unity, b is the maximum value of x. T is half the period or the time required for x to vary from its greatest positive value to its greatest negative.

This sort of variation is exactly that which the E.M.F undergoes in the case of a coil, turned round any axis at a uniform rate in a uniform magnetic field, and is very approximately the case in a large number of motions occurring in practice. It is also the case when a small bar magnet revolves at the centre of a coil, exactly when the magnet is very small compared with the coil, and highly approximately in other cases. The variation of telephonic currents, as produced in a Bell telephone, is also harmonic.

As some of the problems involving alternating currents can be very well exhibited and solved by geometrical methods, I shall give one or two geometrical propositions which will render the diagrams that may occasionally be required easier of comprehension.

PROPOSITION I.

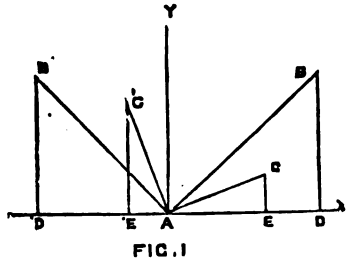

FIG. 1

If A B, A C, are two lines in the plane of A X, A Y, which revolve round a line drawn through A at right angles to this plane, at a uniform rate, the angle C A B being maintained constant, to find a geometrical expression for the mean value of the product of the projections of A B, A C upon A X,

From B and C draw B D, C E, perpendicular to A X.

Draw A B′ perpendicular to A B, and make A B′ equal to A B.

Draw A C′ perpendicular to A C, and make A C′ equal to A C.

Then A B′, A C′ represent the positions of A B, A C after revolving through one right angle.

Draw B′ D′, C′ E′ perpendicular to X A produced.

Then the angle A B′ D′ is equal to the angle B A D, and the angle A C′ E′ is equal to the angle C A E.

Now

$$\text{A E, A D} = \text{A C, A B} \cos \text{C A E} \cos \text{B A D},$$

and

$$\text{A E′, A D′} = \text{A C′, A B′} \sin \text{A C′ E′} \sin \text{A B′ D′} = \text{A C, A B} \sin \text{C A E} \sin \text{B A D};$$

therefore

$$\frac{\text{A E, A D} + \text{A E′, A D′}}{2} = \frac{\text{A C, A B}}{2}\left\{\cos \text{C A E} \cos \text{B A D} + \sin \text{C A E} \sin \text{B A D}\right\}$$

$$= \frac{\text{A C, A B}}{2}\left\{\cos \overline{\text{CAE} - \text{BAD}}\right\}$$

$$= \frac{\text{A C, A B}}{2} \cos \text{B A C}.$$

But the quantity upon the left of this equation represents the mean value of the product of the projection of A B, A C, upon A X, for two positions of the moving system differing by one right angle. And all the positions of the system may be taken in pairs differing by one right angle. But when two such positions are taken the mean value is shown by the above equation to be independent of the actual position of the system.

Therefore, the mean value obtained for two such positions is the mean value for all positions, and is given by the above equation, the right hand side of which shows it to be half the product of A B and A C multiplied by the cosine of the angle between them.

It is unnecessary that the lines A B, A C should have a common point. If A B, C D are any two lines situated in one plane, and inclined to one another at a constant angle, while they revolve round any axis at right angles to the plane containing them, the mean value of the product of their projections on any fixed line in the plane containing them is half the product of their lengths multiplied by the cosine of the angle between them.

The application of these propositions to problems in alternating currents is extremely simple.

Suppose one of the lines we have been considering represents the maximum value of an alternating electromotive force varying harmonically, and acting upon a circuit converging an alternating current also varying harmonically, and that the two have the same period. Suppose the second of the two lines to represent the effective electromotive force through the circuit at a maximum. Then the projections of these two lines may be taken to represent the real value of these two electromotive forces at some instant. If we divide the effective electromotive force by the resistance, we get the real value of the current at the instant, and the product of the electromotive force represented by the projection of the first line into the current at the instant represents the power at the instant exerted by the source of the electromotive force represented by the first line.

Hence, if in the figure A B represent the maximum value of some electromotive force acting upon a circuit whose resistance is R, and A C represent the maximum of the effective electromotive force producing current, then the mean power exerted by the source of electromotive force, whose maximum is A B, is equal to $\frac{\text{A B, A C}}{2\text{R}} \cos \text{B A C}$.

Now, suppose that the only two electromotive forces acting upon the resistance R are represented by A B, B C, when at their maximum, and by the projection of these lines upon any fixed straight line at any other point, then A C is the effective electromotive force acting upon the resistance R. Join A C, and produce it towards A to D, and draw B D perpendicular to it.

Then by what has been said the power exerted by the source of B C is $\frac{\text{B C, A C}}{2\text{R}} \cos \text{A C B}$, and the power exerted by the source of A B is $\frac{\text{A B, A C}}{2\text{R}} \cos \text{C A B}$.

This in the figure as drawn has a negative value, equal numerically to $\frac{\text{A B, A C}}{2\text{R}} \cos \text{D A B}$, which, therefore, repre-

* Dr. Hopkinson has quite recently dealt with some of the cases of alternating currents in a paper read before the Society of Telegraph Engineers and Electricians.

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sents the power doing work upon the source of A B, and, following the same rule, the effective power sending the current through the circuit is $\frac{A C \times A C}{2 R} \cos 0 = \frac{A C^2}{2 R}$.

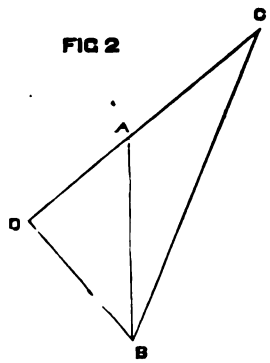

FIG 2

The three powers of the primary source, of the recipient source, and that heating the circuit, are proportional respectively to

B C cos A C B : A B cos D A B : A C, *i.e.*, to C D : D A : A C.

The electromotive force of self-induction is one which depends for its value upon the rate of increase or decrease of the current. It is greatest when the current is increasing most rapidly, *i.e.*, when the current is zero, and it is least when the current is unchanging, *i.e.*, when it is at a maximum or minimum. It varies therefore harmonically, and is in fact an electromotive force which must be drawn in such a diagram of electromotive forces as has been considered at right angles to the effective electromotive force. Its mean power, therefore, in a period must be zero.

To find its maximum value, consider that if 2 T is the complete period $\frac{2\pi}{2T}$ is the angular velocity of any point in the diagram. And if the diagram revolve round one extremity of the line representing the effective electromotive force, the greatest rate of increase of the effective electromotive force is represented by the velocity of the other point.

If e be the maximum value of the effective electromotive force, $e\frac{2\pi}{2T}$ will represent its greatest rate of increase, and this divided by the resistance R, will represent the greatest rate of increase of the current. If, therefore, the circuit has a self-induction coefficient of the value L, the maximum value of the electromotive force of self-induction will be $L\frac{e}{R}\frac{2\pi}{2T} = e\frac{L\pi}{RT}$; therefore, in the diagram $\frac{L\pi}{RT}$ must be equal to the tangent of the angle between the effective electromotive force and the resultant of the impressed electromotive forces.

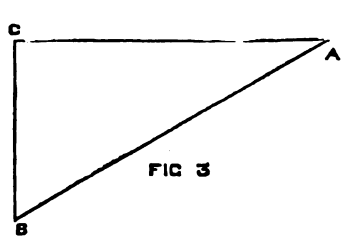

FIG 3

Thus, in the figure, if A B represent the resultant of the impressed electromotive forces, and A C is drawn so that tangent $C A B = \frac{L\pi}{RT}$, and B C is drawn perpendicular to A C, then B C represents the electromotive force of self-induction and A C the effective electromotive force.

Most problems relating to self and mutual induction and to the action of condensers at particular points may be treated geometrically in the way indicated, as will be exemplified occasionally in the following chapters, though the analytical method is probably better in cases of distributed capacity.

The electromotive force of self-induction, properly speaking, exerts no power in a period. It happens, however, that the cores of electro-magnets become warm when subjected to an alternating current, and this effect is generally attributed to the heat from the circuit reaching them by conduction. Some very high authorities have held that the power due to any induced electromotive force must be zero, and that the change of electro-kinetic momentum involves no loss of energy. It is certain that if there be any electromotive force doing work, its projection on the line of effective electromotive force cannot vanish; and if any work is done upon the cores by the changes of polarity in one period, the effective electromotive force will be diminished by the amount of one opposite to it in phase and of such a value that if multiplied by the reduced effective one and divided by twice the resistance, the result will be the power producing the work observed to be done upon the cores. Such an electromotive force is an induced one, but it differs from that of self-induction as usually understood in having its phase in exact opposition to that of the current. In such a case the diagram of electromotive forces would be as in the figure:—

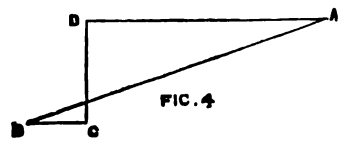

FIG. 4

Here A B is the impressed electromotive force.
A D is the effective electromotive force.
C D is the ordinary electromotive force of self-induction.
B C is the electromotive force resulting from magnetic viscosity, and D C, D A are connected by the relation

$$\frac{DC}{DA} = \frac{L\pi}{TR}.$$

The result of a large magnetic viscosity would be, therefore, to diminish the effective electromotve force in comparison with the impressed one, but at the same time to bring the two more nearly into the same phase; whereas the effect of an increase in the coefficient of self-induction, as commonly understood, is to diminish the effective electromotive force in comparison with the impressed one, and at the same time to increase the difference of phase.

(TO BE CONTINUED.)

THE ANTWERP EXHIBITION.—The date for receiving applications for space having expired, the managing committee is now busy with the work of distribution. The Austrian section will be decorated in mediæval style, embracing two wrought-iron gates, 4½ metres wide and 7 metres high, which were made in the reign of Charles VI. and now belong to the Imperial palace of Vienna. The 114,432 square metres of space, both roofed and open, are to be illuminated under the direction of a special electrical committee, who express a desire that all electric companies and all systems of electric lighting (both arc and incandescent) should be well represented. It is stated that all the Governments except those of Austria and Germany will be officially represented, for which countries, however, influential committees have been formed.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ended 2nd and 9th January, were £2,489 and £2,208 respectively (after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company).

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the two weeks ended 2nd and 9th January amounted to £3,079 and £3,080 respectively.

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THE PROTECTION OF SUBMARINE CABLES.

Extract from the "Bulletin Mensuel des Postes and des Télégraphes" (Monthly Bulletin of Posts and Telegraphs), No. 24, dated December, 1884. (Paris.)

[Translation.]

Law respecting the Repression of Infractions of the International Convention of March the 14th, 1884, relative to the Protection of Submarine Cables.

The Senate and the Chamber of Deputies have adopted, the President of the Republic promulgates the Law, the tenour of which is as follows:—

HEADING I.—*Special Regulations for Non-Territorial Waters.*

ARTICLE 1. Infractions of the International Convention of March the 14th, 1884—the object of which is to secure the protection of submarine cables—which may be committed by any individual forming part of the crew of a French vessel, shall be judged by the Correctional Tribunal, either of the district (*arrondissement*) in which may be situated the port to which the delinquent's ship belongs or of the district (*arrondissement*) of the first port of France into which the vessel may be taken.

ARTICLE 2. The prosecution shall be undertaken at the suit of the Public Ministry, without prejudice to the right of the civil parties.

ARTICLE 3. The minutes (*procès-verbaux*) drawn up agreeably to Article 18 of the Convention of the 14th March, 1884, shall not be subject to affidavit; they shall be held as proved until the requisite steps are taken to prove them false.

In default of minutes (*procès-verbaux*) or in the event of these deeds proving inadequate, the infractions may be proved by witnesses.

ARTICLE 4. Any one who may refuse to produce the documents requisite for drawing up the minutes (*procès-verbaux*) cited in the preceding articles, shall be liable to a fine of from 5 to 100 francs and to imprisonment for a term of two to ten days.

ARTICLE 5. Every assault, every resistance accompanied with violence and the use of force, against the persons qualified by the terms of Article 10 of the Convention of March the 14th, 1884, to draw up the minutes (*procès verbal*) in the exercise of their functions, shall be punishable with the penalties applicable to rebellion according to the distinctions established in the penal code.

ARTICLE 6. Shall be punishable with a fine of 16 to 300 francs:

1. The captain of a vessel who, engaged in repairing or laying a submarine cable, shall fail to observe the rules respecting signals adopted with the view of preventing fouling.

2. The captain or master of any vessel, who, perceiving or being in a position to perceive these signals shall fail to turn away (back) or to keep (himself) at least at the distance of a nautical mile from the ship engaged in laying or repairing a submarine cable.

3. The captain or master of any vessel, who, seeing or being in a position to see the buoys laid down to mark the position of the cables, shall fail to keep (himself) at the distance of at least a quarter of a nautical mile from the line of the buoys.

ARTICLE 7. Shall be punishable (punished) with a fine of 16 to 500 francs, and liable to imprisonment for a term of one to five days:

1. The captain or master of any vessel who shall have cast anchor within a quarter of a nautical mile of a submarine cable the position of which he is in a position to know by means of lines of buoys or otherwise, or shall have moored to a buoy laid to mark the site of the cable, except in cases of circumstances beyond control (*force majeure*).

2. The master of any fishing vessel who shall fail to keep his apparatus or nets at least one nautical mile from the vessel engaged in laying or repairing a submarine cable; fishing vessels, however, which perceive or are in a position to perceive the telegraph vessel shewing the signals adopted, shall, in order to comply with the signal warning, be allowed sufficient time to finish the operation in hand, such time however not to exceed 24 hours.

3. The master of any fishing vessel who shall fail to keep his apparatus or nets at least one quarter of a nautical mile from the line of buoys laid down to mark the position of the submarine cables.

ARTICLE 8. Shall be punished with a fine of 16 to 300 francs and liable to a term of imprisonment varying from six days to two months:

1. Whoever, through culpable negligence, and specially in the cases met by Articles 6 and 7, shall break a submarine cable, or shall cause an injury to it which may result in an interruption, or a hindrance, either entire or partial, to the means of telegraphic communication.

2. The captain of any vessel who engages in the laying or repair of a submarine cable, shall be the cause through inobservance of the rules as to signals adopted with the view of preventing fouling, of the breaking or injury to a cable committed by any other ship.

ARTICLE 9. Shall be punished with a fine of 16 to 300 francs, and liable to a term of imprisonment varying from six days to two months:

1. Whoever shall make, keep out of his house, put up for sale (sell), ship, or cause to be shipped, instruments or apparatus exclusively used for the purpose of cutting or destroying submarine cables.

2. Whoever shall make use of these instruments or apparatus.

ARTICLE 10. Shall be punished with a fine of 300 to 1,000 francs and imprisonment varying from three to five years, whoever shall voluntarily (intentionally) break a submarine cable or shall cause an injury to it which may interrupt or impede, either wholly or partially, the means of telegraphic communication.

The same penalties shall be pronounced against the authors of attempts of the same things.

The guilty party may in addition be placed under the surveillance of the high police for a maximum term of ten years, dating from the day he shall have suffered his penalty.

These regulations, however, do not apply to persons who may be compelled to break a submarine cable or to injure it through the actual necessity of protecting their lives or securing the safety of their ship.

HEADING II.—*Special Regulations for Territorial Waters.*

ARTICLE 11. The regulations of Articles 4, 6 to 10, as above set forth, shall be observed in the case of the infraction having been committed in our territorial waters by any individual forming part of the crew of any ship whatever, French or foreign, without prejudice to the provisions of Article 4 of the Decree of December the 27th, 1851.

ARTICLE 12. The infractions prosecuted agreeably to the terms of the preceding article shall be judged by the Correctional Tribunal either of the port to which belongs the vessel upon which the delinquent embarked, or of the first French port at which this vessel shall touch, or of the place of the offence.

ARTICLE 13. The infractions committed in our territorial waters shall be established (proved) by minutes (*procès-verbaux*), and in default of these by witnesses.

ARTICLE 14. The minutes (*procès-verbaux*) stipulated in the preceding Article shall be drawn up:

By the officers commanding any of the French men of war.
By any of the officers of Judiciary Police.
By any of the sworn officers of Municipal Police.
By the other functionaries enumerated in Articles 10 of the Decree of December the 27th, 1851, and 16 of the Decree of January the 9th, 1852.

Any assault, any resistance accompanied with violence or the use of force, against the agents qualified agreeably to the terms of the above regulations to draw up the minutes (*procès-verbal*) in the exercise of their functions, shall be punished by the penalties applicable to rebellion, according to the distinctions set forth in the Penal Code.

ARTICLE 15. The minutes (*procès-verbaux*) drawn up by officers commanding French men of war are not subject to affidavit: they are held as proved until the requisite steps are taken to prove them false.

The minutes (*procès-verbaux*) drawn up by all other agents qualified for the purpose agreeably to the terms of Article 14 have the force of proofs, and are subject to the formalities laid down by the Special Acts (Laws), particularly Articles 10 and 11 of the Decree of December the 27th, 1851, and 17 and 20 of the Decree of January the 9th, 1852.

HEADING III.—*General Regulations.*

ARTICLE 16. The delinquent in the case of Article 8, Clause 1, shall be bound, within 24 hours of his arrival, to give notice to the local authorities of the first port at which the vessel on which he is embarked shall touch, of the breaking of or injury to the submarine cable of which he may have been guilty.

In default of (such) declaration the penalties incurred shall be doubled.

In the case of Article 10, Clause 4, the author of the break or injury shall be bound, under penalty of a fine of 16 to 100 francs, to make the above declaration.

ARTICLE 17. In cases of second offence the maximum of the penalties announced above may be doubled.

There is second offence:

1. For the acts foreseen by Articles 6, 7, 8, and 9 of the present Act (Law), when in the two preceding years a definitive judgment has been given against the offender for infraction of the regulations of the said Articles.

2. For the acts foreseen by Article 10, when at any period whatever a definitive judgment has been given against the delinquent for infraction of the regulations of that Article.

ARTICLE 18. The parties who have fitted out the vessels, whether the owners or not, in virtue of the fact of fitting out these vessels, shall be declared responsible for the payment of the fines pronounced for the infraction of the present Act (Law) and for the civil condemnations to which these infractions might give rise.

The other cases of civil responsibility shall be settled agreeably to the Regulations of Article 1,384 of the Civil Code.

ARTICLE 19. In cases of conviction for several infractions foreseen by the present Act (Law), the heaviest penalty alone shall be pronounced.

ARTICLE 20. Article 463 of the Penal Code is applicable to the condemnations pronounced for infractions of the present Act (Law).

The present Act (Law), resolved and adopted by the Senate, and by the Chamber of Deputies, shall be executed as a law of the State.

Done at Paris, December the 20th, 1884.

JULES GRÉVY,
By the President of the Republic.

JULES FERRY,
President of the Council,
Minister of Foreign Affairs.

MARTIN FEUILLÉ,
Keeper of the Seals,
Minister of Justice and Worship.

A. PEYRON,
Minister of Marine and of the Colonies.

AD. COCHERY,
Minister of Posts and Telegraphs.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 *p.m.*

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SPECIFICATIONS.

A subject which has provoked a considerable amount of discussion in our columns is that of paying for Specifications. The question has a much greater interest in the earlier stages of the development of any industry than later on. We are not quite sure whether the following statements with regard to the older industries are strictly accurate, but according to our examination they fairly describe the rule.

All ordinary business transactions, except in the case of strict monopolies, are the results of "open tender." We give our custom to one grocer in preference to another, for some such reason as convenience, cheapness, excellence of goods, &c. Every grocer offers his goods at a price, we make the selection. When we consider other industries a difference of procedure is discernible, but still we have the "open tender" system. Thus, in the building trade, for example, it is customary for the person who desires to build to advertise his desire, and select from among those who send in "tenders." The selection is sometimes partly made before the desire for tenders is advertised, giving us the system of "limited competition." This latter system is very general; sometimes, for example, the competitors are limited to a "district," sometimes to "manufacturers," sometimes the work is not advertised in the ordinary way at all, but half a dozen firms of repute are, by a more private method, asked to "tender."

The most common sense view of any business transaction is that a profit is to be made upon the work done. One firm may be satisfied with 10 per cent., another may want 15 per cent., a third will require 20 per cent. or more. We may take it for granted that any firm in sending in a tender has contemplated the acquirement of the percentage decided upon. The "cost price" of the work will differ for each firm, therefore there will be a variation in the amount of tender, even if the profit contemplated be the same in each case. Now, take any simple case, and suppose a charge made for the Specifications, and that each firm obtaining a Specification sends in a tender. Is it not clear at once that the cost of Specification is added on to the prime cost of work, and the tender is thereby increased by this amount and the interest thereon? The tender consists of prime cost + cost of specification + profit. A man must have had few dealings in business who thinks that the "profit" part of this amount will be decreased. The primary object of business is to make profits, and firms carried on with an honest hatred of the bankruptcy court will not do work without a profit. We know enough of more than one great industry to say that profits cannot be lowered in honest transactions. No firm has yet grown rich through its electric lighting work; nor are there any indications of superabundance of profits. Viewing the payment for Specifications in this light it will be seen that the purchaser has to pay.

There is now the second case, where all those who obtain Specifications do not send in tenders. At first sight it may seem that the purchaser obtains an advantage, but if closely examined it must be admitted that his payment is increased by the charge made. For those who are lucky enough to escape the intricacies of estimates, and may not be fully acquainted with the methods followed in business transactions, it may briefly be explained that a firm desires a certain income per annum. The firm has to pay wages—for materials, rent, rates, office expenses, such as for clerical work, paper, stamps, &c. If it is customary to pay for Specifications, the annual amount so paid will soon be averaged and be lumped with office expenses, a percentage of which will be charged on every tender sent out. These payments make up what are known as "constant" charges. Increasing the "constant" charges of an office thus means increasing *pro rata* every estimate. If the firm is not going down hill, these "constant" charges are recouped from the payments received for work done—in other words, the purchaser has to pay, just as he has to pay for materials and the profit of the contractor. The amount the purchaser pays is certainly an average, and may be, probably always is, more, instead of being less, than the actual cost of the Specification.

We state as a general proposition that in whatever way the "constant" charges of an industry be increased the result is the same—an increased price to the consumer. The aim of everyone connected with electric work should be to keep these charges as low as possible, and hence the introduction of the payment for Specification system has met with a well-deserved rebuff.

There are many arguments which might be brought forward, not only against the economy but against the expediency of such a system, and these arguments have tenfold more force when applied to a young and struggling industry.

In conclusion there are and must be exceptions to every rule, and there are exceptions to the non-payment for Specifications. The principal exception is when the drawings accompanying the Specification, or the matter contained in the Specification, are intrinsically worth the amount charged for them. It is almost needless to point out that the drawings of many a great engineering work would be cheap at a far greater cost than is paid for them, and many outsiders would gladly purchase them, or the Specification in which is concentrated the talent of several consulting and acting engineers. Frequently but few drawings are made, in order that things valuable in themselves, and containing information which individuals or companies desire to keep secret, should not by any chance come

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into the hands of the public. When this is so, the purchaser of the Specification gets full value for his money, just in the same way as he would if he had purchased a valuable book. It is frequently the case that a schedule of quantities accompanies the Specification, for which a special charge is made. The providing of such a schedule does not exempt the contractor taking out his own quantities, but there is little doubt it saves him far more than the cost usually charged. We have not specially gone into those cases in which the amount charged is returned upon the receipt of a *bonâ fide* tender, as they are really included in the general argument.

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the remarks of Dr. Stone (p. 188) upon my letter (p. 150), I must point out to him that my principal object was to correct the serious errors in Professor Dolbear's statements, so as to prevent these from passing uncontradicted through the Press into general acceptance. My own statements were merely incidental and illustrative rather than positive. But I must now submit to Dr. Stone that his own figures, however true in fact, are misleading, and may be dangerous. He says I "re-assert erroneous statements" as to the resistance of the body, because I said that resistance is, from hand to hand, from 5,000 to 1,000 ohms, and he gives two instances of lower measurements which he has obtained. He speaks of "620 ohms instead of 5,000, per Sprague's minimum." But in this case he has introduced two fundamental differences. I was speaking of the "ordinary condition" of the body, such as may be expected in cases of accident. I submit that the cases will be very rare in which the contingent subjects of accidental contact with conductors will have taken much care to "overcome the transitory deception and dangerous skin insulation" by soaking the hands in salt water. In most cases the hands would be more apt to be dirty and oily, and the resistance approach or exceed my maximum rather than come down to this 620 ohms. In fact that was the very point of my remarks on this particular stage of the subject. I was contending that Professor Dolbear's figures were exaggerated by taking unlikely conditions, whereas the probable resistance would be increased by the small surfaces in contact, and I really cannot see in what way Dr. Stone's patient, with his carefully-prepared hands, affects my point.

But as a matter of scientific truth I object to measuring resistances in the manner adopted by Dr. Stone in this case, because I do not believe that it measures resistance at all. I consider that when we pass alternating E.M.F. into an electrolyte a very large part of the current shown is a delusion; that it does not pass through the electrolyte, but is a mere succession of charge and discharge of the surfaces, and that in measuring this as resistance on a bridge we are leaving out of account what is really a large shunt circuit, and the result is an apparent reduction of the resistance. I should attach no weight to any resistance measure unless it was based upon the steady and direct transmission of an electric current, testifying to the conducting capacity of the thing measured.

As to the physiological actions of electricity I should not think of comparing my knowledge with that of Dr. Stone, but I should like to ask him whether his suggestion as to possible coagulation of the blood is derived from any actual examination or is simply hypothetical. I am under the impression that the clotting of blood by the electric current is purely a secondary action of the products of electrolysis, and occurs only around one pole, while the bulk is unaffected. That is one of the actions which I indicated as likely to produce instant changes in the resistance if any large current were commenced.

As Dr. Stone seems to find something mysterious in my observation, which I thought simple enough, I may explain further that the effect of the setting up of difference of potential across living tissues must resemble the action in a series of condenser leaves, which we know move and rustle and are attracted together. So the different cells which form the tissue must, by the different conductivities of the liquids and the cells themselves, undergo an attraction which we recognise in the convulsive contraction of the muscles. It appears probable that such contractions, rapidly repeated may, at a certain limit, result in actual rupture. From what little we know of nervous action it is also probable that the nerves themselves may be rendered incapable of transmitting that energy upon which the continuance of life depends. I think that it is in this direction we must look, rather than to the effects of real electric currents measureable by Ohm's formulæ. Of course, adequate energy must enter the body; that is the meaning of the difference between the moderate shock of an induction coil and these fatal accidents. And here, of course, we are all at one. E.M.F., quantity, and time all enter into the problem, which, after all is rather how to avoid the risk of danger than the mode in which the body suffers injury.

This involves the now recognised fact that an alternating current is more dangerous than a continuous one (for the reason I have given) in which the same E.M.F. is operating; in fact, the continuous current gives one blow to the system, followed by some slight electrolytic action which may or may not be of consequence, while the other gives repeated rapid blows. One other consequence is that external induced charges are set up, and therefore a single contact is sufficient to produce effects from either conductor, while with continuous currents there must be a derived circuit set up through the body between two points.—Yours, &c., J. T. SPRAGUE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In the discussion which followed Dr. Hopkinson's excellent paper upon Alternating Currents, recently read before the Society of Telegraph Engineers and Electricians, I was permitted by the kindness of the president, Professor W. G. Adams, to point out among other things certain effects upon the current generated by an alternating E.M.F. of capacity in the conductor, whether situated at a point or points, or distributed along the conductor, and I gave rules by which these effects may be in certain cases calculated.

The chief effect of such capacity is to increase the current in sections near the source of E.M.F. in comparison with those more remote.

Now, certain observations and experiments which I have made, lead me to the belief that the tissues of the human body through which an alternating current is sent exhibit very considerable capacity as well as mere inert resistance. This is a theory which explains, *inter alia*, much in connection with fatal and serious accidents. Its physiological explanation must be left to such men as Dr. W. H. Stone and Dr. W. H. Gaskell.

If it is true, it is not surprising that a test made to discover the resistance of the body upon the assumption that it is only a mass possessing inert resistance, by means of an alternating current machine, whose force has, perhaps, been determined upon measured inert resistance, should lead to small and erroneous results.

I have also pointed out that self-induction, which is almost always largely present in alternating machines, up to a certain point may act favourably in a circuit possessing capacity, which is not the case when mere resistance is in circuit.

If Dr. Stone, and Professor Dolbear, and the learned professors of Cooper's Hill College will apply the rules governing these actions to experiments made with the good instruments which they have at command, they will be doing a service to to science and humanity. As a preliminary test suppose they took the following series:—An alternating generator—a dynamometer—a man—a second dynamometer—a second man, and of these in this order made a closed circuit. Then, the alternations being set up, the first dynamometer will show more current-squared than the second.

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The experimenters must not expect to arrive at a fixed value for the capacity, as if the tissues were a sheathed electric cable or a Leyden jar. The capacity will probably be found to be, like that of a voltametric series, variable with the charge.—Yours, &c.,

THOMAS H. BLAKESLEY.

Athenæum Club, Pall Mall.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As I pointed out in the discussion on Dr. Stone's paper at "The Healtheries," the consideration of the physiological actions of the electric current is extremely difficult, for the reason that it is a question demanding an intimate knowledge of two great subjects—physiology and electricity—and no life is long enough, and no intellectual powers strong enough to compass it. Electrical engineers must necessarily be ignorant of the construction of the human or any animal body. The very utmost that anyone can have acquired will have been in his early students days, when he has taken it up as a subject, with others. Once he is launched on his career as a breadwinner, he can have little time to return to the subject, no matter how great may be his interest in it, all his leisure being taken up in keeping pace with the times. And, on the other side, the *rôle* of medical men is pretty well that of the busy bee.

It has always appeared to me, however, that the question of the resistance of the body *per se* was very much like the size of a piece of chalk; it varies with the dimensions, in this case, of the electrodes. Take, for instance, on the one hand, the case of a man immersed up to his chin in a metal bath containing hot acidulated water and grasping a large copper electrode connected with one end of the battery, while the bath itself is connected to the other. As half a dozen Smee cells are sufficient to give him a moderate shock if the circuit be interrupted, it is evident his resistance must be very small. Take, on the other hand, the case of a man whose hands are hard and dry, whose feet are encased in a thick pair of boots, and who stands on a dry slate ridge some distance above the ground and touches a wire carrying an electric light current with one hand.

I believe I should be correct in saying that under such conditions the resistance of the man would be so high that he would hardly feel any shock at all, though he might be near the positive terminal of the machine and large variations of current strength might be taking place within the electric light circuit.

The electrical conditions of danger were pointed out by Professor Ayrton, I believe, in his lecture at the London Institution some two years ago. They are two-fold.

1st. If a man interpose his body or a portion of his body between two points in an electric circuit between which great difference of potential exists, and if the conditions of the circuit made up of the generator, that portion of the wires between the generator and his body, together with that portion of his body which he has included in the circuit, be such that a current can pass of greater strength than his body in whole or in part can bear, then he receives an injury of a more or less serious description.

The meaning of this is clearly that if the resistance of that portion of his body which is in the electric circuit be, no matter from what cause, sufficiently low, a dangerous current will pass. As an instance of this I may mention the case of a man accidentally touching two brushes of a 40 light brush machine with *the back of one hand*.

The other condition is, if a man by touching a part of an electric light apparatus at a potential very much higher than that of the ground places himself as a derived circuit to the electric light circuit, then if the latter be not very well insulated, and if changes of great magnitude occur within the electric light circuit, the *extra current* will discharge, or a portion of it, through his body; and it is clear that here also the conditions of discharge depend on the resistance which his body, or so much of it as may be within the branch circuit, offers to the passage of the current.

It is evident that if he presented an infinite resistance he would receive no portion of the current. It is equally evident that if his body conducted infinitely well he would receive it all.

But the question is not affected, in my opinion, by how much of the current he receives. It is how great an excess has passed through him, or through one of his organs, above that which it can take without injury.

It has always appeared to me that Dr. Stone's measurements of his 7 feet of clinical clerk, and more recently the patient whose resistance he mentions as having measured from foot to foot—a case that can rarely occur in practice—are so much time wasted. The fact that certain men have been killed under certain conditions is proof positive that under those conditions they received more current than was good for them, and that their resistance must have been below a danger figure. What we wish to know is not the outside conditions, but the *inside* conditions.

If Dr. Stone's clinical clerk would submit to an exhaustive series of tests, to ascertain how much current he could stand in different parts of his body, it appears to me that whatever the result was it would be worth far more for practical purposes than thousands of measurements of that will o' the wisp—his absolute resistance.

I suggested to Dr. Stone, at the Healtheries, that before he would do much good he must plan out the human body into circuits, just as a telephone or an electric light engineer would plan out his circuits of lamps or telephones. He must be able to say, if a current enters the body at such a point and leaves at another point, it divides itself between such and such blood vessels, lymphatics, nerves, &c. The current passing in this artery acts inductively on the current passing in that vein; this vein being a conductor in motion sets up an electromotive force within itself, and so on. From which it will be deduced that when a certain current passes between two points, a certain fraction of that current, representing a certain current strength, passes through a certain very delicate organ. What is the result of the passage of that current through that organ? Does it infuse it? Does it heat it unduly? Does it distend it? and so on. It appears to me that this is the direction in which inquiry should go.

I understood Dr. Stone to say at the Healtheries that this could not be done. That certain facts were known—viz., that blood was the best conductor and bone the worst, and we must make the best of those facts. I take this to mean that it has never been tried, and that it is difficult. After the beautiful models and diagrams of the human body which I have seen, and which are public property, I will not believe it to be impossible; but I will say that, if the difficulty be shirked, electrical engineering science, still in its infancy as we are so constantly told, must be far in advance of the older science. Are not far more difficult problems faced daily? Take the reactions in a dynamo and a motor, for instance.

Now, as to the manner in which the current may cause injury. Given the fact that an injurious strength does pass—and here I wish to join issue most distinctly with Dr. Stone as to the question of lightning—I understand Dr. Stone to hold that the effects of lightning stroke, if I may use the term, are not the same as those produced by high tension electric lighting currents. To my mind the only difference is that which arises from the enormous tensions of the thunder cloud. It is very much the same as the difference between boiling water and molten iron.

All the effects that have been produced by lightning can be reproduced by electricity artificially generated, provided the same conditions be observed; and it appears to me that whenever we go away from the known laws of electricity, and try to explain apparent inconsistencies by some new law that we introduce for the purpose, we are raising up stumbling blocks in our own path, and with our own hands. It is our want of knowledge that makes the effects which we see apparently inconsistent with the laws which we know.

Perhaps there could hardly be a better instance of this than the one Mr. Sprague shows of the Holtz machine. Apparently Ohm's law does not govern the discharge, and yet, if all the conditions be taken note of, it is quite evident that it does.

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There are several ways in which, in my opinion, an electric current may act injuriously upon a human body.

1. By shock.

2. We know that an electric current has the property, when passing through a nerve, of exciting that nerve to perform its natural function. Those who have given any attention to the matter know also that the strength of the current required to excite a nerve is very small indeed. In fact, one of the most marvellous points about the whole thing is the ridiculously weak currents which, when properly applied, do such great things.

We have, then, when a high tension current passes through the human body, first a violent excitation of all the nerves which lay in its path, followed very quickly by a violent contraction of the muscles that are controlled by the excited motor nerves. We know that this is so, because we have many recorded instances of men who have accidentally taken hold of wires carrying high tension currents being unable to release themselves, the muscles of their hands having contracted and clasped them on the wires.

What happens next? In the case of the alternating current we should have excitation and contraction followed by a momentary return to the normal state, and then re-excitation; and it is this violent succession of shocks which, as Mr. Sprague has pointed out, is so much to be feared.

The path of the current from hand to hand leads directly through the lungs, passing on its way some of the large vessels leading to the heart, and, most important of all, the pneumo-gastric nerve, which physiologists tell us may cause a stoppage of the heart's action should it receive a very sudden impulse.

I think we may fairly infer that, in many cases at least, particularly where both hands take part in transmitting the current, this pneumo-gastric nerve, receiving the sudden impulse delivered by the current, stops the heart's action. A second result that we must also expect from the passage of an electric current of high tension through a body of such high resistance as the human body would be that heat would be developed.

Apparently, however, this has not played a very important part in the injuries that have been effected by the current, with the exception of a scarring the skin of the hands, where the conductor has been grasped, and I think also in one instance of the face, where it had accidentally come into contact with the conductor. We have no record of any appearance due to heat in any other part of the body, or anything that could lead us to suppose that heat had played any part in the killing. On the other hand there are, I believe, authentic records of men and animals having been burnt to a cinder by a lightning stroke, showing that such might be possible under favourable conditions. The reason that we see no trace of heat except at what I may call the electrodes is, I believe, that once inside the body the current divides into so many branches, and as the heating effect varies with the square of the current, it rapidly diminishes.

But it must not be forgotten that however small the current in one of the branches into which it divides is, if that branch contain some delicate organ that cannot withstand even the small portion which falls to its share, serious injury and even death may result.

May it not happen, for instance, that one of the delicate portions of the lung may be scorched. How long would a man live under such conditions?

Another effect that I think we may look for from the action of a current of electricity upon the human body, is a quickening of those secretive actions upon which the well-being of the animal depends.

We know that each organ of the body receives the components it requires from that general carrier and purveyor, the blood, by means of a process of exudation through the membranes dividing the organs from the blood vessels; and we know also that the electric current has the property of causing liquids to pass through a membrane. Therefore it appears to me that these secretive actions may be quickened both by the stimulus given to the nerves, and by the direct action of the current itself. How is this action affected by the E.M.F. of the current? May it not be that there is a violent increase of these secretive actions, causing a derangement of other parts of the system? Knowing what a delicate apparatus the human body is, may it not be that in some such action as this the secret of the mischief is to be found?

It appears to me that this is eminently a field for experiment by the medical profession.

Another effect, it appears from Dr. Stone's letter, may be expected, viz., thrombosis, or coagulation of blood in the living vessels. I thought I understood Dr. Stone to say, at the Healtheries, that this thrombotic effect was an abnormal distention of the blood vessels. I am not clear whether these are the same, whether coagulation takes place first and distention afterwards.

I presume that the result is a stoppage of the circulation of the blood, causing, of course, cessation of life.

May not this distention be caused by the increased endosmotic action I have referred to? and may not there occur a more or less general mixture, fluids and secretions getting into places where they do injury, producing by their chemical action upon other fluids substances which may be highly injurious to the system?

Here, of course, we must remember that in all cases, so far as I am aware, what is done is done at once. I am not aware of any case of a man having lived for any time after receiving a stroke either from lightning or from an electric light current, except in those cases where they have felt no evil after effects whatever.

At the same time it certainly appears worth investigating whether men may not be injured, though not mortally, by the passage of too strong a current through them.

There is another effect which I think we have all of us overlooked, and that is the mechanical effect.

Professor Dolbear and Mr. Sprague have both rightly pointed out that time plays an important part in the question of whether a current does injury or not.

Electric light engineers know well that a conductor will stand a very much larger current for a short time than it will continuously, for the reason that heat takes a sensible time to develop. We find, therefore, in those cases where the E.M.F. is very large in proportion to the resistance of the body struck, and yet the quantity of current very small indeed, that mechanical effects of great magnitude are produced. A chimney stack will be hurled to the ground, large pieces have been taken out of the solid walls, heavy marble-topped tables hurled about like shuttlecocks, and all with very little indication of heat.

Remembering that the work done depends on $\frac{E^2}{R}$, there is evidently sufficient energy in a lightning flash to perform an immense amount of work, though the current developed may be small. May it not be, therefore, that some injury may be done mechanically to the internal organs, again causing death? I am exceedingly surprised that so little has been made of the opportunity that presented itself in the summer when the death occurred so unfortunately at the Healtheries. There were many peculiar points about this.

The tension of the machine was not the highest that is used, being only 1,250 volts; and, further, as far as I could understand from the report, the unfortunate young fellow did not receive the whole force of the machine. If I remember rightly, he touched one part with one hand, became giddy, or something akin to that, rolled over, and placed his other hand on another part. I believe it was distinctly stated that he did not touch the terminals. If this is correct it would point to something new—was the man's blood in a bad state? and what did the *post mortem* disclose?

I wrote twice to St. George's Hospital for information on the subject, but my letters were not even acknowledged. It is rather a striking commentary on the position taken up by Dr. Stone, and the reproof administered by him to the Royal Society for refusing his application for their assistance in his researches, that his own professional brethren should bar the way when an opportunity occurs of turning a terrible lesson to advantage.

I am sure the whole electrical profession will support me when I say that we are quite ready to do our part, so far as

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we know how, to lessen the possibility of danger from the use of the powerful agent we handle; but, on the other hand, I think we should have the liberal aid of the medical profession in unravelling that portion which must necessarily lay beyond us.

The remedy for high tension currents is *not* to do without them, though it may be a grave question if they have not been introduced too early, but to know how to use them with safety. The advantages for extended lighting, and for transmission of power are so great that he who can show us how to use slight tension currents harmlessly, without dressing our workmen like "puss in boots," will be a public benefactor.

I think that the medical profession can do much in this direction if they will, and I think we shall all feel deeply obliged to those who, like Dr. Stone and Dr. Althous, lead the way.—Yours, &c.,

SYDNEY F. WALKER.

195, Severn-road, Cardiff, January 12, 1885.

HEATING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In common, doubtless, with many of your readers, I would thank Sir David Salomons for his letter and for the figures he gives. As a distinguished *dilettante* in the science of electricity, and as one who has spent much money and time upon it, anything he writes should command consideration; but I must confess that I do not quite see the *rationale* of his "warning."

I have drawn attention to the subject, feeling that it is one of sufficient importance at the present juncture, when great developments are taking place, to merit discussion, and to bring about if possible practical work. I have not done so without having good grounds for the belief, and indeed proof of the fact, that *for many purposes* heating by electricity can be carried out successfully and with a degree of convenience and comfort unattainable by any other known means.

It is not necessary for me to criticise Sir David Salomons' figures, for I certainly did not intend to convey any such suggestion as that "open coal fires or approved stoves" may be considered as things of the past, or that heating by electricity can be at present economically effected in positions or under conditions when such arrangements are readily available.

I hope, however, that Sir David Salomons' letter may be the precursor of many others, and that the subject may secure the attention and at least the *experimental* working out which I am bold enough to assert it deserves. I would wish to remark that when writing my letter of the 30th ult. I did not know of the existence of a very interesting patent, which I have just read, taken out by Mr. J. S. Williams in 1881 (No. 5233), which deals in a very comprehensive manner with this subject and is well worth perusal to those interested.—Yours, &c.,

JOHN S. SELLON.

The Hall, Sydenham, January 15, 1885.

SMALL MOTIVE POWER FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am glad to see in your issue of the 3rd inst. that Mr. Greenhill refers to the great want of a good motor for domestic lighting.

Those who, like ourselves, use the electric light for business purposes, take badly to gas in our homes. My reason for troubling you with this letter is to ask if you, or any of the readers of *The Electrician*, have had any experience with a new domestic motor made by Messrs Hathorn, Davey, and Co., engineers, Leeds, and said by them to require no more attention than a gas engine (and of course applicable where gas is either not available or very dear), to work at about 5lb. pressure, and to answer well for driving small dynamos?—Yours, &c.,

D.

[We saw this engine at the last meeting of the Royal Agricultural Society at Shrewsbury. It is said to have been considerably improved since. Mr. Davey, we believe, uses one to drive a dynamo at his own house. Perhaps he would give us some information on the subject.—ED. *E.*]

ELECTRO-MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I gather from the ingeniously-worded letter in your last issue that "Volt-Ampere" is desirous of obtaining some practical rules for winding electro-magnets, and although I, too, look with silent awe upon those "double fiddle f's," yet I venture to present a few simple figures, both in the hope that they may be of some service to your correspondent and that they may call forth some more able demonstration.

In the first place, I will assume that the iron core is to be far from saturation, as is imperative in the construction of the field-magnets in dynamos.

In such a case the strength of the "field" may be expressed in ampere turns, and given a certain required strength in ampere turns, and a given difference of potential between the ends of the coil, the diameter of the wire may be calculated as follows:—

Let T = the ampere turns required
E = difference of potential in volts between the ends of the coil
n = number of turns on bobbin
r = resistance of bobbin in ohms
C = current in amperes
x = the length of a mean convolution in inches
d = diameter of wire in mils

We may take as a standard that a wire of 1 mil in diameter and of 96 per cent. the conductivity of pure copper 1·106 inchs measures 1 ohm. Then the resistance of any wire will be

$$\frac{\text{Length in inches}}{1{\cdot}106\,d^2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 1.$$

From the conditions we have

$$T = \frac{E\,n}{r} = C\,n; \frac{n}{r} = \frac{T}{E}\text{constant} \quad . \quad . \quad . \quad 2.$$

$$r = \frac{x\,n}{1{\cdot}106\,d^2}, \; d = \sqrt{\frac{x\,n}{1{\cdot}106\,r}}.$$

By Equation (2) $\frac{n}{r} = \frac{T}{E}$,

$$\therefore d = \sqrt{\frac{x\,T}{1{\cdot}106\,E}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad 3.$$

Having now found the diameter, it is obvious that if E is constant, as we are assuming it to be, T will also be constant, whatever n may be; for r varies with n and C varies inversely as r by Ohm's law. It is, however, necessary to make n sufficiently large as to avoid over-heating. This is readily calculated from the formula $d = 32\sqrt{C}$, whence $C = \left(\frac{d}{32}\right)^2$ being the maximum current which should be used on the stationary coils of dynamo machines to avoid wasteful heating. The wire should then be coiled on until $r = \frac{E}{\left(\frac{d}{32}\right)^2}$.

In conclusion, I would recommend "Volt-Ampere" to study Professor Silvanus Thompson's new book, "Dynamo Electric Machinery," which is probably the most valuable work for the practical electrician that has yet been written. Trusting that I am not encroaching too much on your valuable space, I am, yours, &c.,

G. C. FRICKER.

7, Charlwood-road, Putney, Jan. 10, 1885.

CONNECTIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you kindly tell me how the connections of a Gramme machine are made, as I am winding one and do not understand how the fields are connected; also what results ought I to get from 10lbs. of 16 B.W.G. on the fields, and 1½lb. No. 20 B.W.G. on the armature. I want to light 10 C.P. lamps.—Yours, &c.,

A. E. R.

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PROFESSOR FORBES' PAPER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret to see two errors in my note of last week. The extraordinary formula for R is, of course, a misprint for

$$R = 2{\cdot}031 \times 10^{-6} \text{ ohm.}$$

The statement in the last sentence that a sheet of copper 1 c. × 8·9 metres would weigh about 1·5 ton per lineal foot should have been 530lb. This is somewhat amusing, considering that I was correcting a mistake which arose in a precisely similar way.—Yours, &c., W. H. SNELL.

BRAKES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: What would be the best form of "Prony," or friction-brake, to apply to the first motion shaft of a water-wheel, to ascertain the amount of power available, with a given fall and volume of water, for driving a dynamo machine?

The wheel makes fifteen revolutions a minute, and has teeth on internal segments of the periphery, into which a small pinion on the first motion shaft is geared. This shaft is about three and a half inches in diameter, and will make about 110 revolutions.

The object is to find out really what power can be depended on, so that the right size of dynamo may be put down.—Yours, &c., DANAE.

THE STOCK EXCHANGE INSTALLATION.

We herewith give diagrams of the arrangements of the electrical apparatus as used at the Stock Exchange. The space

FIG. 1.

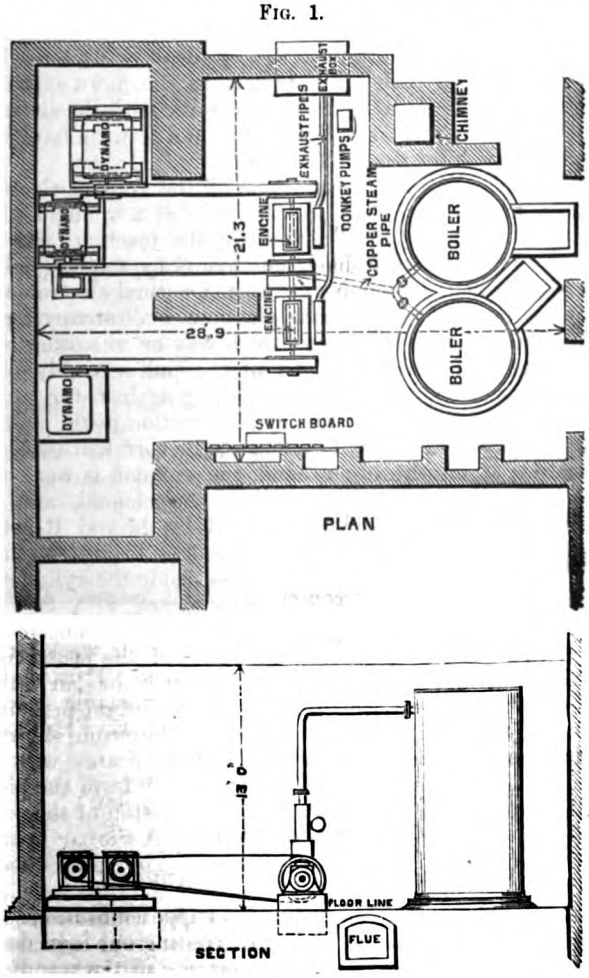

FIG. 2.

at the command of the contractors is very small, and, unless the dynamos had been run direct, the best use has been made of what is available. We have not before described the Willans engine, which has lately come into use for electric lighting purposes, and we are glad of this opportunity to illustrate it. As we stated last week, two engines are affixed, either of which can if necessary do the work at present required. Figs. 1 and 2 show a plan and elevation of the apparatus.

The engines, which were made by Messrs. Willans and Robinson, of Thames Ditton, are of the latest type of the Willans special compound engine for electric lighting, which differs in many respects from Mr. Willans' still better known marine engines. They are designed to indicate 60 horse-power each, at 600 revolutions per minute, and at this high speed they work with great silence and steadiness. To be seen to the best advantage they ought to be coupled directly to the dynamos, but owing to the great working speed of the latter this is impracticable, and they are driven by belts in what may be called the old-fashioned way. The high speed of the engines has, however, the advantage of rendering counter-shafting unnecessary, and to this extent space is saved, over and above the saving due to the small dimensions of the engines themselves, the base of each engine measuring only 3ft. 2in. by 2ft. The high-pressure cylinders are of 4½in. diameter, and the low-pressure 9in., the stroke being 6in.

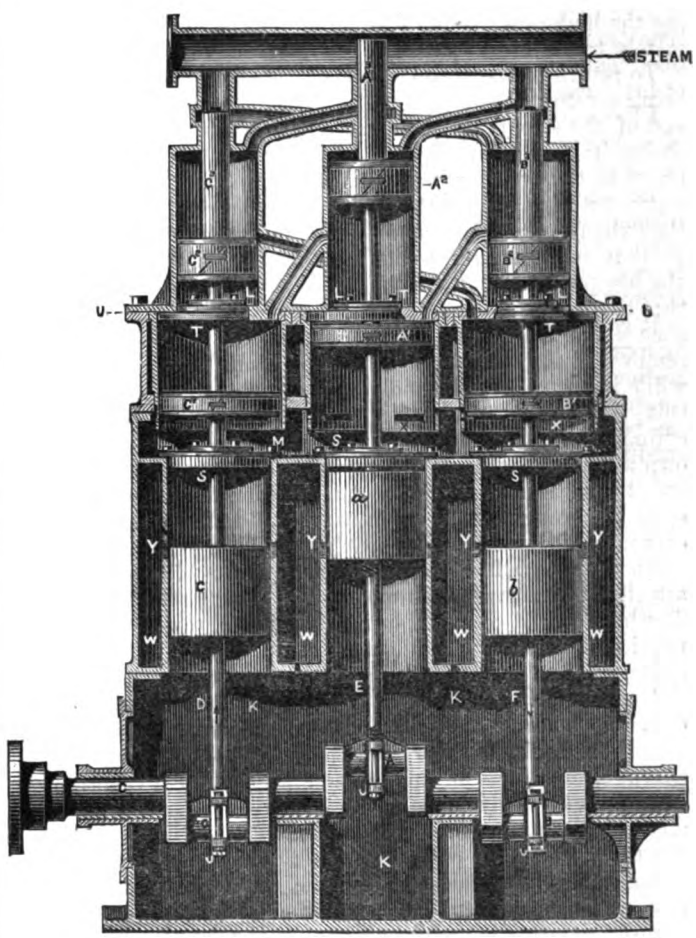

FIG. 3

Each of the pistons driving the three cranks A, B, C, consists of three parts, viz., (1) the low-pressure piston; (2) the high-pressure piston; (3) the cut-off rod or trunk, forming the valve for one of the high-pressure cylinders; *a*, *b*, *c* are the crossheads, taking the form of deep trunk pistons without rings, moving in guide cylinders. The latter are open to the crank chamber at the bottom, and are lubricated by the splash from the cranks. D, E, F are the connecting rods, of ample length; G, the crank shaft, running in phosphor-bronze bearings. The cranks and connecting rods work in the "crank chamber" K, containing oil, which is continually splashed up in spray over all the bearings, and up the inside of the hollow crosshead pistons to the steel pins upon which the upper ends of the connecting rods work. As there is constant down

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thrust upon all working parts there is not much occasion for brasses *below* the crank pins, but to guard against accident brasses are fitted, but of reduced length. As they rarely, if ever, come into action, the setting up of the brasses is a matter which at most needs attention at very long intervals.

The three cranks being set at equal angles of 120 deg., the piston B^2 has just the proper lead of A^1 to enable it to supply A^1 with steam, with cut off at three-quarter stroke, and admission at the commencement of the stroke. This describes not only the relation of B^2 to A^1, but of A^2 to C^1 and of C^2 to B^1. Exactly similar relations exist between the cut-off rods B^3, A^3, C^3, and A^2, C^2, and B^2 respectively.

The cut-off rod B^3, which supplies steam to A^2, commences to uncover the ports leading to A^2, when the latter is at the top of its stroke. B^3 (on its way up) closes these ports again, when A^2 is at three-quarter stroke. At about the same time, A^2 begins to uncover the ports in the side of its own cylinder, which allow the steam, still acting upon A^2, to act also upon C^1, then at the top of its stroke. From this point, until A^2 reaches the bottom of its stroke, the steam expands on A^2 and C^1 together. A^2 then commences to rise, against a pressure which rapidly diminishes as C^1 continues its down stroke. When C^1 has travelled three-quarters of its stroke, A^2, rising, has covered up the port. Thenceforth the steam shut in above A^2 has no exit, and the clearances are so proportioned (including the high-pressure passages) that it is compressed approximately to the initial pressure.

To return to the steam above C^1. Communication with A^2 being severed, this continues to expand until, just before the end of the stroke, C^1 commences to uncover the oblong ports shown in the figure. By these openings a great part of the steam in the cylinder, and what is of great importance, *all the water*, are ejected into the space X, which communicates with the exhaust. It will be noticed that the position of the exhaust ports is much nearer to the lowest position of the piston in the low-pressure than it is in the high-pressure cylinders, and that the ports are consequently uncovered for a much shorter time. The reason of course is that, in the one case, the removal of the steam and water has alone to be considered, while in the other the time of opening has to be adjusted to suit the desired period of admission for the low-pressure cylinder. By the time C^1 has again closed the ports of its own automatic exhaust, the upward movement of A^2 has placed the steam still remaining above C^1 in communication with the space L, through which it can pass away to the exhaust (by an opening not shown) during nearly the whole of the upstroke.

The rods by which the high-pressure parts of the pistons are attached to the low-pressure parts pass through metallic glands, T, which consist only of spring rings like piston rings, and require no packing. Similar glands, S, separate the exhaust space, X, from the guide cylinders and the crank chamber.

Mention has been made of compression in the high pressure cylinders, where—chiefly owing to the considerable fraction of the stroke during which it takes place, and the character of the curve of compression in relation to that of expansion—it involves extremely little loss. Little or no compression is given in the low-pressure cylinders, and in the Willans engines of the marine type the compression in the high-pressure cylinders is alone amply sufficient to give the required "holding-down power," and to keep the connecting rod brasses always in thrust against the crank pins, and the crank-shaft always against the lower side of the main bearings. But at the very high speeds required in electric lighting work, other provision has to be made; and the special means adopted to absorb the momentum of the moving parts during the up-stroke are amongst the most characteristic features of the Willans engine. Besides its wastefulness when carried to excess, compression of steam in the cylinders is open to the objection that under varying conditions of working varying effects are produced. To avoid these, recourse has been had to a different fluid, which is always available and of which the character and pressure are invariable. Upon the upstroke of each piston work is put into the compression of *air*—to be given out again without appreciable loss upon the succeeding downstroke. The means by which this is effected, without adding any parts to the engine, is the subject of a separate patent. The cylinders in which the piston guides, *a*, *b*, *c*, work are closed at the upper end. At Y, Y, Y, are holes opening into the chamber W, the latter being in communication with the atmosphere, and by drain holes at the bottom with the crank chamber K. Towards the end of the downstroke the guide pistons uncover the holes, to ensure that the air-pressure in the cylinders shall be restored once in each revolution to that of the atmosphere. On the upstroke, as soon as the holes are covered, compression commences, and is carried to an extent governed by the amount of clearance provided (which can be varied within certain limits). On the next downstroke the air assists in driving the engine. Even if by the action of the governor, or by other means, the steam is wholly shut off while the engine continues to run, the effect of the "air-buffers" is not impaired; they are wholly independent of steam pressure, and the valve action of the engine may be designed without the smallest reference to questions of compression other than that in the high-pressure cylinders already referred to. It need not be said how great an advantage this is, or how largely it contributes to the remarkable economy achieved by these engines.

The most striking feature of the installation, from an electrical point of view, is the use of the Willans Electrical Governor, for regulating the speed of the engines, so that by varying the speed the electromotive force may be kept constant. How great progress is being made by Mr. Willans' invention is shown by the fact that already upwards of forty of these governors have been either applied or are about to be applied in installations. Even in the case of compound-wound machines it is becoming apparent that an electrical governor, which will keep the speed at least as uniform as the best centrifugal governor so long as uniformity is to be desired, and varies it if variation should be necessary, is preferable to a governor which can at best perform but one of these functions. But the electrical governor is seen to the best advantage when applied to shunt machines, which not only can scarcely be used without it (where great variations have to be dealt with), but which become, when used with it, as perfect as the more expensive compound machines. By arranging to work with the electrical governor, therefore, Messrs. Woodhouse and Rawson have been enabled to use shunt-wound machines.

In Fig. 4, which represents one of the Willans electrical governors in question, A A are the coils of a solenoid which form a shunt between the terminals of the machine, and B is an iron core suspended inside the solenoid by a spring, so adjusted that when a current due to the normal electromotive force is passing through the coils, the core shall occupy a position in which a small movement one way or the other shall not materially affect the strength of the pull upon it. The solenoid, it will be understood, is pulling against the spring, so that if from any cause, such as a reduction in the number of lamps, the current becomes stronger, the core will be drawn downwards; if, on the other hand, the current is weakened, the spring will overcome the pull of the solenoid, and will raise the core. The latter is connected by the rod R with a small double piston valve, P, which works inside the main hydraulic piston P^1, as the latter works inside the cylinder X. The hollow piston rods N and N^1—connected with P^1—pass through the ends of the cylinder X, and N^1 is connected by the rod F with the throttle valve, which is of the piston form, and works inside the casing T. The piston P^1 has an annular space round it, M, into which water or other fluid pressure is admitted by the pipe S. By a passage therefrom, shown in dotted lines, the annular space M communicates with the annular space between the two pistons which form the piston valve P. A passage, K, leads from the lower piston of the piston valve P to the upper end of the cylinder. A similar passage, K^1, leads from the upper piston of the piston valve P to the lower end of the cylinder.

In the position shown the current is supposed to be constant and the mechanism is at rest. If now the current is increased, the piston valve P is lowered by the lowering of the core B, and pressure is admitted to the top of the large piston P^1 by the passage K, which is uncovered by the lower piston of the piston valve, and at the same time the space below P^1 is opened to the exhaust by the passage K^1 and the hollow rod

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N. This causes the piston P^1 to descend, and as it descends it closes the throttle valve by means of the rod F, and reduces the speed of the engine and dynamo, which in turn weakens the current and so stops the downward motion

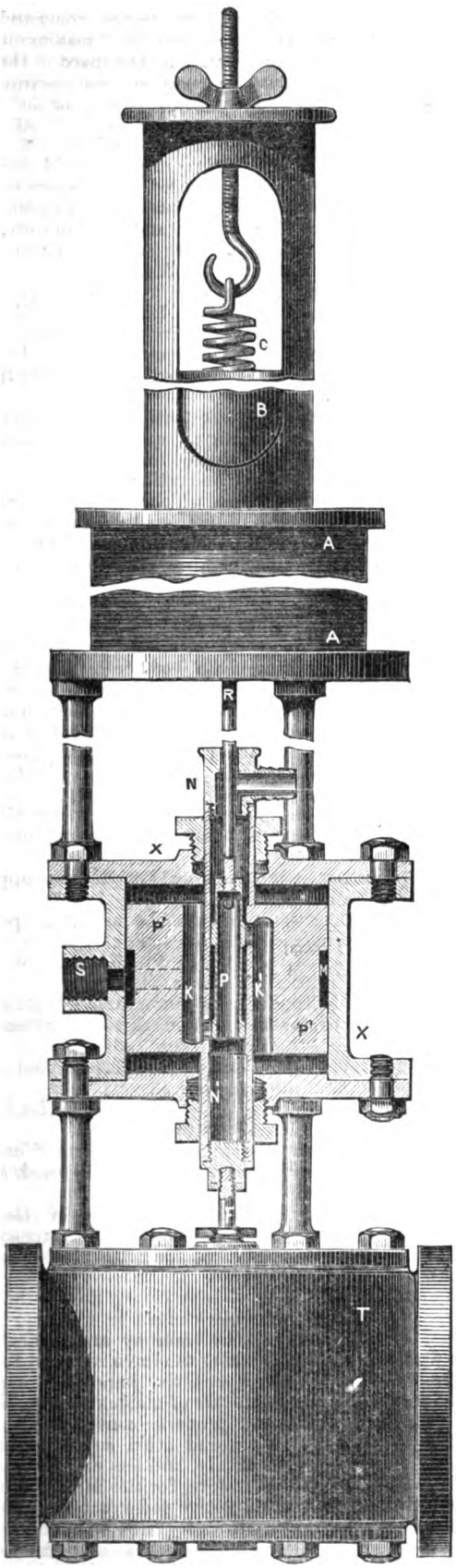

FIG. 4.

of the core B and the piston valve P. The latter coming to rest is immediately overtaken by P^1, and the passages K and K^1, being brought opposite to the now stationary piston valve, are closed, and the motion of P^1, owing to the inelastic fluid employed, is also immediately arrested. If the current is weakened the reverse action takes place. The sequence of the various actions described is extremely rapid, and consequently the piston P^1 follows so closely upon the piston valve P that the stopping or slowing of the latter produces an instant effect upon the motion of P^1, and "hunting" is entirely prevented. This overtaking action is in a measure analogous to the so-called "differential action" found in various steam steering gears, but it need not be said that the manner of its application is entirely different.

It is hardly necessary to point out that no solenoid of practicable dimensions could exert power enough to move the throttle valve direct, and that the system of using the pull of the core to bring another and greater power into action—in other words, the use of a relay—is essential to the efficient working of such an apparatus. But the substance of the invention, and that to which it owes its practical success, is the combination with the relay motor of interaction between the motor and the valve which starts it. To this alone is due the elimination of "hunting," and the absolutely steady action of the apparatus. The Willans governor assumes various forms to meet different requirements, but that which we have illustrated may be considered the standard form for actuating a throttle valve.

VIENNA EXHIBITION.

REPORT ON THE WOODHOUSE AND RAWSON LAMPS.

Professor Dr. Erasmus Kittler, Professor Dr. Antonio dos Santos Viegas, Dr. Josef Haubner, and Dr. E. Maiss, the jurors of the Vienna Exhibition, report as follows :—

In the first tabulated statement it will be seen that the lamps, even when run far below their normal candle-power, have an exeeedingly high efficiency. For instance, it will be seen that whereas a 20 candle-power lamp has an efficiency of about $2\frac{1}{2}$ watts when it is running at about 12 candle-power, it has an efficiency of 3·13 watts per candle-power, about equal to the Swan lamp; and when running at about 8 or 9 candle-power, an efficiency of about 3·77 watts per candle-power, equal to the Edison lamps. Of course, when the lamps are under run in this way the length of life should be very considerable.

The second statement gives the average efficiency of the total number of lamps tested, namely, 2·38 watts per candle-power, or 312 candles per horse-power :—

Normal C.P.	Observed C.P.	Current in amperes.	Difference of potential in volts.	Resistance hot in ohms.	Watts absorbed.	Watts per C.P.	No. of normal candles per electric H.P.
20	4·64	0·779	35·24	45·26	27·44	5·91	122
	6·85	0·838	37·65	44·95	31·54	4·60	160
	8·98	0·869	38·92	44·80	33·81	3·77	196
	10·85	0·905	40·35	44·59	36·51	3·37	219
	12·18	0·926	41·21	44·52	38·14	3·13	235
	15·58	0·966	42·83	44·34	41·38	2·66	277
	20·32	1·018	44·88	44·10	45·67	2·55	327
	26·27	1·071	46·92	43·79	50·27	1·91	385
	34·24	1·126	48·93	43·44	55·11	1·61	456
	45·81	1·193	51·25	42·95	61·16	1·34	515
Average of total number of lamps tested.							
20	20·78	10·72	46·26	43·71	49·38	2·38	312

These tests agree very well with the Wimbledon tests made by Mr. Preece upon the Woodhouse and Rawson lamps, which however, were lamps of a little later make. Messrs. Woodhouse and Rawson tell us that the lamps for the Vienna Exhibition were made over a year ago, and at the present time the lamps are much better, there having been a steady improvement since.

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EVOLUTION OF THE ELECTRIC RAILWAY: Its Commercial and Scientific Aspect.*

BY DR. W. ADAMS, MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

(CONTINUED FROM PAGE 168.)

We must consider something besides the mere propulsion of a car. Electricity possesses innumerable novel and superior qualities or features which have never heretofore been presented to the railway constructor, although fully appreciated by railway economists. It behoves us to grasp and make the most of these. To be sure, some kind of operation may be for a while attained at maximum outlay, in a primitive impractical manner, but that which should be striven for is maximum economy as regards mechanical return, and such perfection in operation as will insure a minimum wear and tear. The application of electricity to railway propulsion means a complete revolution in railway construction and manipulation. In dealing with electricity as an agent of locomotion, it is unnecessary that we should adhere to those methods and processes which experience has demonstrated as essential to steam locomotion. On the contrary, having a totally different element to deal with, new problems are presented, and new principles involved. In handling the question of steam locomotion, Stephenson, after giving preference to the principle of traction over cables, concluded that it would be decidedly best to apply the power directly to each axle, or, better still, to each wheel of every car, and operate each car separately. Finding such an arrangement impossible, however, he next decided upon making each car at least its own locomotive. But this system also proving impracticable with steam, he, as a *dernier ressort*, adopted the "train system," with its ponderous locomotive. Had Stephenson and his followers found it as practicable with steam as we now find it with electricity to apply the power to direct each wheel, the long "train system" of locomotion would never have been instituted. One of the first requirements, therefore, of an electric railway system embodying the elements of permanency and commercial success, is the abolishment of the locomotive and its essential dead weight, which in turn does away with the "train system" and its numerous objectionable features. When a number of cars are coupled together their wear and tear and weight are necessarily greater. The impetus of a train being thus increased, it becomes more difficult to stop it, and the results of an accident are more disastrous both to life and property. The amount of air always carried between the cars of a train offers great resistance. All curves must be of higher degree than would otherwise be necessary, and a very much larger percentage of power is lost in making the curves than would be the case in a system applying the power to each wheel or axle. In the train system, if one car catches fire, or jumps the track, others are very likely to do the same, and thus again is the company's yearly expense greatly increased. The cars being individually heavier, and the necessity of providing for the weight of the aggregate number of cars massed together in the train system, increases the cost of the road-bed and all culverts and bridges. When we dispense with the locomotive and its attendant dead weight, we abolish the cost of the power consumed in propelling the same, and we greatly lessen the principal cause of wear and tear of the road-bed, culverts, bridges, &c., and, furthermore, we render possible the use of much lighter rails, and thus again further reduce both the first cost of construction, or the capital invested, and the cost of operation. Cars which are not being continually bumped together and wrenched to pieces by a heavy train may certainly be built lighter. In the locomotive train system the weight which must be provided to supply a proper amount of adhesion between the rails and the wheels is a *dead* weight, requiring as much power for its propulsion as is required by the remainder of the train; in fact, nineteen tons of dead weight must be hauled for every ton of passengers carried. Furthermore, this necessary dead weight is a fixed quantity, and does not vary with the actual paying load to be hauled. The adhesive power and its attendant dead weight to be propelled remain the same whether the accompanying cars are but one-tenth filled, or fully loaded, and railway statistics show that the average number of passengers carried by each train is but 70; whereas in a system having the tractive power distributed, whether the cars be run singly or in trains, the weight which gives the adhesive power is more nearly proportionate to the load to be carried; and the weight which contributes this adhesive power is not a dead weight, but one that the operators of the road receive pay for. As each passenger enters a car, an additional weight is supplied for the exertion of just as much extra traction between the rails and the wheels as is required to propel such an increase in the load.

Here, then, we have an expenditure directly proportionate to the demand, the height of economy being thus attained. A no less important indication in railway propulsion looks to the application of the power *directly* to the point where it is to expend itself. Be this never so desirable, however, such a thing is impossible with steam, but in every way practicable with electricity—indeed, electricity seems here to have found its grandest and most important application. Again, an all important indication for a successful electric railway may be said to lie in the fact that an electro-dynamic machine, when operating with greatest economy and safety, must, like a generator, run at a predetermined maximum speed. Hence, provision must be made for varying the speed of the car by some other means than by varying speed of the electric motor. Means must be provided for allowing the armature, or that portion of the electric motor which revolves at a high speed, to attain full headway independently before any load is placed upon it, and the latter should be applied gradually in order to avoid jerks. In addition to the economy and safety insured by this arrangement, we, in starting, allow advantage to be taken of the impetus of the motor in overcoming the inertia of a car, and, furthermore, we do not compel the motor to do its work rapidly, since it is a *sine quâ non* of an electric motor that it shall do its work slowly. Thus it will be possible for an electric car to attain maximum speed almost at the start, whereas from an eighth to a half mile is required for a steam engine to acquire its running speed. This one point alone renders electricity, when properly applied, particularly suitable for city surface and elevated roads, where frequent stops are necessary.

It must also be possible to vary the quantity of electricity running through the car, or, rather, of varying the quantity tapped from the main supply, without introducing useless resistance. There must, furthermore, exist at the central or generating station an automatic regulator, or equivalent arrangement, which will keep the supply of electricity in the mains always proportionate to the demand, and which shall regulate the amount of fuel consumed in the steam engine so that it, likewise, will be proportionate to the power or electric energy absorbed throughout the system.

But little, if anything, has been done towards developing the electric railway outside of what Dr. Siemens did in 1879, namely, the simple mounting of an electro-motor upon a car and connecting this up by means of a leather or chain belt, or by a train of cogs, with the car axle. Siemens at first built an electric locomotive, but we notice he soon abandoned this principle and began mounting his machines on each car and connecting these up with the axles by means of belts. Evidently, his discerning mind soon grasped the situation, and he began applying the power in a way better calculated to develop the superior advantages of electricity.

Edison and Field, however, have adhered to the locomotive principle and train system, as witness their exhibitons at Chicago and Louisville.

It certainly requires but little mechanical knowledge to appreciate the weak points about all these.

In the first place, either the cars must be mounted upon their axles rigidly without springs, or else the motor, which is mounted upon the car, and the axles with which the motor is geared, will move differently and will not always be in line.

Second, no form of belting will do for a practical commercial railroad—that is simply out of the question, as every engineer must concede at once.

Third, gearing between parts which move differently and are constantly getting out of line is also impractical.

But little has been done towards thorough insulation for the conductors, and in devising a practical moving contact.

Absolutely nothing has been suggested as a means of economic regulation, in every instance useless resistance being used, and the current wasted in useless heat.

To recapitulate:—Among the many advantages of electricity properly applied as a motor over steam for passenger transport, is the circumstance that no heavy machinery or fuel has to be carried about to set the train in motion. The carriages running singly may be built much lighter, thus reducing the power necessary to move them, reducing the noises made in running, greatly lessening the wear and tear of both tramway and rolling stock, reducing the first cost of cars, reducing the force required to brake the cars when going at a high speed, the impetus being less; reducing the force of concussion in case of accident, and hence the dangers and destruction to life and property consequent thereon; and, finally, permitting all bridges and other superstructures to be built more cheaply, more artistically, and less weighty than has heretofore been possible. Furthermore, for the same reason, and also because of the distribution of motive power attainable, greater speed may be acquired, sharper curves rounded with less than the usual wear, and steeper grades may be climbed. Experienced and trained engineers and firemen are not required to operate an electric railway. Any boy possessed of ordinary intelligence may be taught in half an hour to manage a car perfectly and cause it to perform all the work of a steam locomotive. This feature alone does away with a great source of expense now incurred by all steam railways, whether elevated or surface. The electric system also admits of the use of large, stationary, protected steam engines of the most economical type. The use of these as against small, ex-

* Paper read before the Society of Civil Engineers, America.

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posed, portable ones, reduces immeasurably the wear and tear, as well as first cost, and also the amount of fuel necessary to develop a given amount of power; and if water power be utilised—as would very frequently be possible—the cost of operating such a railway system can be reduced to a comparative minimum. Further advantages are: Ability to get up speed quickly, which is particularly desirable for street and elevated roads; absence of noise; freedom from liability to many forms of accident now unavoidable, and from the annoyance of flying sparks, cinder, smoke, gases, grease, and the many other offensive and dangerous accompaniments of our steam railway system.

The time is now surely at hand for the economic and advantageous employment of electricity as a cleanly and cheap means of effecting rapid passenger transportation through densely populated cities and across the Continent. Jacobi, Davenport, Davidson, Little, Pinkus, and Page were in advance of the age in which they lived. No more rapid transit was demanded at that period of the world's history. The dynamo-electric machine which we have seen has rendered feasible the electric railway was not then in existence; hence they were obliged to apply electricity as a primary motor, an office which is filled far more economically by the steam engine, as was shown by their contemporaries in science, those versed in mathematics and thermo-dynamics. Now, however, the time is ripe for its introduction. We have reached the period of transition from the stage of practical demonstration to that of practical application. We now know how to apply electricity as a *secondary* motor; the dynamo-electric machine has been introduced as an industrial feature of our age; the project of electric railway transportation *now* has the sanction and enthusiastic support of the learned in the sciences of electricity, dynamics, and mathematics; and, lastly, we live in an age which demands more rapid transit. We think fast and live fast, and this naturally begets an almost insatiable desire and necessity to travel fast. Railroad managers are expected to provide the means of gratifying this desire with safety to passengers and without detriment to their earnings, if possible; but at all hazards to put trains through according to the latest and fastest schedule. For a number of years the regular time between New York and Chicago has been 36 hours, or a speed of 25 miles an hour, including stops. This is not what might be called slow; but the impatient public is more than ever impressed with the idea that "time is money," and that something better than this should be accomplished, in view of the improvements in rails, road-beds, and rolling-stock. Managers, in order to meet this demand, are put to a terrible strain. They must provide the ways and means, head off competition, take the responsibilities and risks of accidents, and, what is more important than all, they must make the traffic pay.

This last requisite, in the face of rival fluctuating rates, the enormous dead weight of locomotive and tender, of sleeping and drawing room cars, and the excessive wear and tear of track, superstructure and rolling-stock, from the increased weight necessary to effect such rapid transit *with the steam system*, is not an easy thing to respond to. Managers, master mechanics and car builders have for a long time regarded the rapidly increasing weight of trains as a growing evil that should be checked to prevent expenses from swallowing up earnings in passenger traffic. Fast running under existing conditions is extremely hazardous as well as expensive, and this simply because of the enormous weight given to railway trains. The tractive force of twenty to sixty tons exerted by the driving-wheels of a locomotive on an eighth of an inch of rail soon tears a tramway to pieces. These conditions are practically reversed in the writer's electric railway system. It might almost be said that here the lighter the rolling stock the greater the possibilities as to speed. Calculations based on the numerous points of advantage herein specified show that an electric railway may be operated at an average speed of sixty miles an hour for one-third the cost of operating by steam at the same speed.

If the train system must be discarded as least calculated to develop the advantageous qualities of electricity as applied to railway propulsion, then a practical method of applying this power upon each car must be devised, and this has by many eminent engineers been found to be no easy matter, but, on the contrary, a most complex question, fraught with many difficulties. The armature of the electric motor must run at a high speed, and its power must be transmitted to the wheels of the car by a *positive* gearing. All forms of belting were at first sight seen to be entirely impracticable; while gear wheels between parts moving differently were not to be considered. Everything electrical and mechanical, including that fundamental law of mechanics which directs that power shall in every instance be applied as *directly* as possible, seemed to point toward a direct application to the wheels. But how was this to be accomplished? As we have before noted, the armature or revolving part of the electric motor must move at a very high speed, entirely too high for the speed of a car wheel. And, furthermore, it is very evident that it was impossible to construct an "armature" upon the modern dynamo principle which should also serve as a car wheel—such a dual function was out of the question. And yet it was imperative that the principle of the motor should be that of the most efficient type of the modern dynamo.

However carefully the reader may examine into our simple solution of this question, no adequate conception can be formed of the amount of thought and work which has been bestowed upon it.

We have succeeded in applying the power directly to every wheel, to the point of traction, where the power is absorbed, the work done, and yet our wheel is neither an "armature" nor a "field" of a dynamo. It is both combined! In other words, every wheel is a dynamo in itself. Each wheel is *animated*, having power within itself. Hence every wheel becomes a veritable locomotive.

(TO BE CONTINUED.)

LEGAL.

Important Case as to the Issue of Debentures.

EDWARDS *v.* THE DUPLEX ELECTRIC LIGHT COMPANY.

In the Chancery Division of the High Court of Justice, on the 14th inst. (before Vice-Chancellor Bacon), an action was brought by Mr. John Edwards, a tool manufacturer, of Waterloo Bridge-road, as the holder of certain debentures in the defendant company, to enforce the due carrying out of the debenture deed, dated the 17th May, 1883, made between the defendant company on the one part and the defendants John Mallard and Stephen H. Emmens on the other part, under which the debentures were issued; and for all necessary inquiries to be made, and a receiver to be appointed.

Mr. Marten, Q.C., and Mr. Asheton Cross, instructed by Mr. J. N Jonas, appeared for the plaintiff; Mr. Millar, Q.C., assisted by a junior, instructed by Messrs. Munns and Longdon, for the liquidator of the company; and Mr. Livett, instructed by Mr. F. T. Rushton, for the trustees of the debenture deed.

It appeared that the Duplex Electric Light Company was floated in May, 1882, for the purpose of taking up Mr. S. H. Emmens' patent. After the company had been started a year, in May, 1883, owing to the company being pressed by various creditors, Mr. Emmens, who had been appointed the manager of the company, made a proposal to the directors that they should issue debentures on the whole capital and stock of the company for £20,000, in 2,000 shares of £10 each; and a resolution embodying that proposal was accordingly passed at a Board meeting held on the 8th of May, 1883. On the 6th of January, 1883, a petition was presented for the winding-up of the company by the British Trading Company, who alleged that they were creditors, but Mr. Jonas intervened on behalf of Mr. Elmore, of the Elmore Electrical Works Company, on the ground that the petitioning company was also one of Mr. Emmens's promotion, and that therefore the petition was collusive. The winding-up order was made on the 14th July, 1883, by Mr. Justice Pearson, and Mr. Wm. Waddell appointed official liquidator and receiver on behalf of Mr. Elmore and the other creditors. Upon Mr. Waddell absconding Mr. Samuel Lovelock was appointed in his place, and now opposed the enforcement of the deed on the following grounds: 1st That there was no proper quorum of directors present at the Board meeting at which the resolution in question was passed; and 2nd that the debenture deed was not executed as a Bill of Sale in conformity with the Act of 1882, inasmuch as the consideration was not rightly stated.

Mr. MARTEN, Q.C., on behalf of the plaintiff, contended that at the Board meeting on the 8th of May, 1883, there was a proper quorum of directors present, the number of directors required to form a quorum being three, and at that particular meeting there were present Captain G. F. Hunt, E. B. Ilidge, C. Drake, and Mr. Emmens, as shown by the agenda and minute books of the company, in the former of which a resolution was entered to the effect that the debentures were approved and signed. The learned counsel then went on to argue that the Bills of Sale Act did not apply to the liquidation of a company, and called the attention of the Court to the 17th section of the Act, which he said specially provided that the Act was not to apply to the debentures of a company. In the course of his argument the learned counsel quoted several cases, amongst others that of the Romford Canal Company, 24 C. W., p. 85, and Webbe *v.* the Commissioners of Herne Bay, 5 Law Reports, 5 Q. B.

Mr. LIVETT, on behalf of the trustees of the debenture deed, adopted the same argument as his learned friend Mr. Marten had used.

Mr. MILLAR, Q.C., for the defence, urged the debentures were bad because they were issued without a quorum of directors, and said that he should call witnesses to prove that three directors were not present at the meeting, and that Mr. Emmens was not a director of the company at all. The debentures were issued to the shareholders on the following terms—that for a £10 debenture credit should be given to them for the £5 paid on their shares, and that they should have a £10 debenture by paying another £5. The whole proceeding was utterly irregular. It was only proposed to issue debentures to the shareholders, and the company was to take in payment fully paid up shares, and the company was to be made to bank its own capital. The minutes of the proceedings at the Board meeting had been prepared since, and were grossly inaccurate. In the agenda book on one side was written "Proposal as to issue of first mortgage debentures," and on the other side "Approved, subject to counsel's opinion." So that the resolution was only a conditional one, subject to

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counsel's opinion, and he would challenge his friend Mr. Marten to show that counsel's opinion had been obtained in favour of the scheme. The learned counsel then read several letters which had passed between Mr. Emmens and Mr. Rushton (the company's solicitor) on the subject, one of which states that counsel had given an opinion opposed to the scheme.

The Court here rose for the day, and the further hearing of the case was adjourned.

HOLLINGS *v.* THE CONSOLIDATED TELEPHONE COMPANY.

This was a claim for £79 11s. 4d., balance of account for the supply of telephone generators made by the plaintiff, and supplied to the defendant company. Mr. Atkinson appeared for the plaintiff, and Mr. Metcalfe for the defendants.

Plaintiff said he was a machinist, carrying on business in Kerby-street, Hatton-garden, and he had for some years manufactured an instrument called magnetic generators for the company, in quantities of 1,000 at each order. When the generators were delivered they had to be accompanied with bell-handles and frames, and special castings, screws, &c., were required for this work. His first transaction with the company was in 1881, when he received a verbal order for 1,000 castings, which were delivered and paid for. A similar order was executed in 1882, and in October, 1883, he got an order for 40 gross of poles, which were all delivered and paid for. In May, 1883, he received a letter from the company ordering 1,000 generators, with bell-handles and frames, which were all delivered in November of that year. In October, however, he got a verbal order to repeat the order of the preceding May for the 1,000 generators; but whilst he was executing the latter a pattern was sent for some trifling alteration in the manufacture. Half a-dozen samples of the new pattern were made and submitted to the then manager of the company (Mr. Rose), who was quite satisfied; and on 22nd January, 1884, Mr. Rose gave him a verbal order for 1,000 of these generators, for the manufacture of which he had been obliged to make new tools. In February he delivered 200, which were accepted and paid for by the company, and down to the following April 138 more were also sent in. On 1st April, however, he received a letter to the effect that Mr. Rose had severed his connection with the company, and on receipt of that circular he saw Mr. Curtoys, the secretary, and asked who he (plaintiff) was to look to for future business. Mr. Curtoys said it would not make the slightest difference, that he was quite satisfied with the work which had been done, and that plaintiff would be perfectly justified in proceeding with the contract he had in hand. He sent in his account up to March 29, and added a foot note stating that the goods then delivered did not include those in course of manufacture. According to instructions he made 300 more, and had them in hand. Just before Easter he again saw Mr. Curtoys, who asked him how many he had in hand, and he said 300 partly made, and asked for his account to be laid before the company, so that he might get a cheque. Mr. Curtoys then said he did not know that the company owed plaintiff anything, but the clerk brought the account to February, which amounted to about £90. When he told the secretary he had 300 in hand, Mr. Curtoys said he could not receive them then, as they were taking stock, and they had only a few men at work. In April he received a letter to the effect that no goods were to be delivered without a written order from the company, but all the generators supplied were by the verbal order of the late manager, Mr. Rose.

Mr. METCALFE contended that these orders were irregular from the start, and it was found necessary that orders could not be given in that way.

The learned JUDGE pointed out that some of the goods had been received before that date, and it did not matter whether the secretary knew of it or not.

A JUROR remarked that the company ought to have seen their instructions carried out.

Mr. METCALFE: If the jury have made up their minds——

The JUDGE: Did the company make a new rule with regard to an order which had been partly executed?

Mr. Metcalfe resumed his seat, whereupon

The JUDGE, amidst some amusement, remarked that the counsel for the defence had "gracefully retired," and by his direction the jury gave a verdict for the amount claimed—£79 11s. 4d.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.

Report of the Directors, to be presented at the 12th ordinary general meeting of the Company:—

The Directors submit their report and the accounts of the Company for the year ended 30th September, 1884. The total earnings amount to £106,174 8s. 4d., a decrease of £6,532 2s. 8d. compared with last year, caused by the interruption of the Brazilian Submarine Company's cable. The working expenses for the year, exclusive of renewals of cable, amount to £61,871 5s. 2d., as against £61,127 19s. 11d., an increase of £743 5s. 3d. These expenses include £1,129 14s. 6d. for depreciation of steamship "Viking," an item which did not enter into last year's accounts. Including the amount brought forward from last year, the balance to the credit of the revenue account is £18,757 8s. 9d., from which, for the reasons given hereafter, the Directors regret they cannot recommend the payment of a dividend. In consequence of the interruption of the Brazilian Submarine Telegraph Company's cable between St. Vincent and Pernambuco, referred to in the last report, and of a second interruption of the same section from the 2nd to 28th March, 1884, the revenue of the Company derived from international messages was almost entirely wanting for no less a period than 101 days The duplication of the cables of the Brazilian Submarine Telegraph Company, which has since been effected, will in all probability prevent the recurrence of such a serious loss to the revenue of the Company. The Company has had to replace by sheathed cable during last year 382 miles of the old unsuitable type of cable; the amount thus expended, £36,622 12s. 1d., has been charged to the renewal fund. On the other hand, the Directors have credited the same fund with £15,000, part balance from revenue account, absorbing the amount which otherwise would have been available for dividend. Attention has been repeatedly drawn to the reasons which necessitate the employment of two steamers, and the gradual removal of the old strand type of cable. The greater portion of this type has now been replaced by sheathed cable, and such lengths as still remain will be dealt with in the same manner. Until the Company's system consists of sheathed cable from end to end, the Directors must provide against interruptions in the strand cable, which should never have been laid in the first instance, and the interruptions in which have been the source of constant difficulty. The mileage of the strand type has been reduced from 2,500 to 450 miles, and the Directors consequently hope to make arrangements in reference to the repairing ships which will shortly reduce the heavy outlay now necessary. The Company would have suffered to a much more considerable extent from competition had they not been in a position to effect speedy repairs with these vessels. Notwithstanding the reduction in tariff made by the Company last year, the revenue shows a very satisfactory growth, and the Board think it right to state that the revenue for the first quarter of the current financial year not only shows that the loss of last year has been recouped, but that the traffic is in excess of any previous year. The general position of the Company, financially and otherwise, shows decided improvement. The retiring Directors are Mr. C. W. Earle and Mr. H. Weaver, who offer themselves for re-election. The auditor, Mr. Weise, retires, and is eligible for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. JAN. 14.		BUSINESS DONE WEEK ENDING JAN. 14. Highest.		Lowest.	
Anglo-American	30,	31	32⅛		30⅛	
Do. Preferred	54,	55	56½		54½	
Do. Deferred	7½,	8	8		—	
Brazilian Submarine	10⅝,	10⅞	10⅞		—	
Cuba	11,	11½	—		—	
Do. Preference	17½,	18½	18⅝		18	
Direct Spanish	2½,	3	—		—	
Do. Preference	11,	12	13		11½	
Direct United States Cable	9⅞,	10	9 15-16		9⅞	
Eastern Telegraph	11⅝,	11⅞	12		11⅞	
Do. 6 per Cent. Preference	13⅞,	14½	14⅛		13⅛	
Do. 5 per Cent. Debentures, 1899	105,	108	106½		—	
Eastern Extension	12⅛,	12⅜	12⅛		12⅛	
German Union	9½,	10	10⅛		9⅛	
Globe Telegraph and Trust	6⅞,	7	7 1-16		6 13-16	
Do. Preference	12⅜,	12⅝	12⅝		12⅝	
Great Northern	14½,	14⅝	14 11-16		14 7-16	
Indo-European	32,	33	—		—	
Reuter's	7½,	8	7⅞		7½	
Submarine	175,	180	—		—	
West India and Panama	⅝,	¾	—		—	
Do. 1st Preference	7½,	7⅞	7⅝		7 5-16	
Western Brazilian	6⅛,	6⅜	6 11-16		6⅛	
Western Union 7 per Cent. 1st Mortgage	120,	125	—		—	
Do. 6 per Cent. Sterling Bonds	100,	103	—		—	

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	—		—	
Oriental	⅛,	⅜	—		—	
United Telephone	11½,	12	11⅝		11 11-16	

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	1½		—	
Do. (fully paid)	3¼,	3⅝	3½		—	
Hammond Light (£3 15s. paid)	⅜,	½	½		⅜	
Swan	¼,	½	—		—	
Maxim-Weston	3-16,	5-16	—		—	

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35½		34½	
India Rubber, Gutta Percha, and Telegraph Works	21,	22	22½		21½	

TRAFFIC RECEIPTS FOR DECEMBER, 1884.

COMPANIES.	Dec., 1884.	Dec., 1883.	Increase.	Decrease
Cuba Submarine	2,500	2,559	—	59
Direct Spanish Telegraph	—	—	—	—
Eastern Extension	41,426	35,335	6,091	—
Eastern Telegraph	53,036	49,181	3,855	—
Great Northern	19,000	—	—	—
West Coast of America	3,750	—	—	—
Direct United States	—	—	—	—
Submarine	—	—	—	—

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NOTES.

HELIGOLAND.—The cable between Neuwerk and Heligoland is interrupted.

THE TELEPHONE IN AMERICA.—Boston and New York are now telephonically connected.

WORKS LIGHTING.—We learn that Messrs. Sharp, Stewart, and Company, of Manchester, have decided to light their works by electricity.

HEATON MERSEY.—The postal authorities have taken steps to ascertain the number of telegrams sent to this district, in order to decide whether or no a telegraph line shall be erected.

EARTHQUAKES AND EARTH CURRENTS.—We are a little surprised to learn that nothing exceptional has been noticed with regard to earth currents during the recent earthquakes in Spain.

COLLIERY WORK.—The Tirpentwys Colliery owners have adopted the electric light for the external part of their colliery. It is found to work very satisfactorily, and other companies contemplate its adoption.

ELECTRIC LIGHT AT AOSTA.—On the 1st inst., the lighting of Aosta by Ceruta lamps and Thury dynamos, under Professor Farinet and the engineers Taddei, Carrone, and Garnier, was inaugurated amid great popular rejoicing.

CURRENT METER.—The Gerboz measurer of electric current depends for its action on the gauging of a quantity of water, which only flows while the current passes. The latter actuates a number of valves by means of an electro-magnet.

CROOKHAVEN.—The laying of the cable connecting Lloyd's Signal Station on the Fastnet Rock with the mainland has been successfully accomplished, and connection is being made between the cable and the Postal Telegraph Office at Crookhaven.

INTERNATIONAL EXHIBITION AT THE ALEXANDRA PALACE.—The administration have, it is reported, concluded an agreement with the Gülcher Electric Light Company for illuminating the palace and grounds with the largest combined installation in England.

THEATRE LIGHTING.—It is reported that the Court Theatre, Monaco, is to be entirely illuminated by the electric light, the conductors consisting of six underground cables, and that the chief mechanician has patented a form of incandescent lamp for giving novel effects of coloured light.

FLIRTATION BY WIRE.—It is said that the loss of time due to trivial communications between the lady clerks and the subscribers at one of the principal New York telephone offices became so serious, that the manager had all the shunt circuits put in communication with his office, with the desired result.

AN ELECTRIC CHRISTMAS TREE AT ST. PETERSBURG.—This year when the Empress of Russia's cuirassier regiment and the Emperor's special escort had their annual Christmas tree at the St. Petersburg manège, in the presence of their Majesties, the tree was lighted partly by small Edison electric lamps.

THE JABLOCHKOFF ELECTRIC LIGHT COMPANY V. HOWARD AND WYNDHAM.—The reclaimers on Wednesday withdrew their note in this case, as an extra-judicial arrangement had been arrived at between the parties, with a view to the renewal of the electric light installation under improved conditions.

THE TELEPHONE AT INVERNESS.—The National Telephone Company has opened an exchange in Union-street, Inverness, connections having been made with about fifty of the principal business houses in town and suburbs, while it is expected that connections will shortly be made with the neighbouring towns, such as Nairn and Dingwall.

TELEPHONE BETWEEN FRANKFORT AND MANNHEIM.—It is reported that the local authorities of Neu-Isenberg, Spendlingen, and Langen oppose the passage over their territory of the telephone wires for connecting Frankfort and Mannheim, and that the whole question as to this "right of way" is now before the German law courts.

SKATING BY ELECTRIC LIGHT.—Advices from Brussels say that there has been skating on the lake in the Bois de la Cambre for several days, and that the lake has been temporarily lighted by electricity at the expense of the Ixelles Steam Tramway Company, which ran five cars, drawn by two engines, every ten minutes up to midnight.

ELECTRICAL EXHIBITION, PARIS.—The Electrical Exhibition, organised by the Société Internationale des Electriciens, with the co-operation of Admiral Mouchez, at the Paris Observatory, is announced to open on the 15th March. Applications for space will be received up to 10th February, at the company's head-quarters, 3, Rue Séguier, Paris.

THE TELEPHONE IN AMERICA.—The United States Telephone Company is preparing to establish lines in New Haven and elsewhere throughout Connecticut in opposition to the Southern New England Telephone Company, which at present exercises a virtual monopoly of the business. The United system is claimed to be superior to that of the Southern.

JOINING COTTON BELTING.—The jumping of cotton belts, imperfectly joined, has been a cause of difficulty in driving dynamos. In reply to a correspondent, the *Timber Trades Journal* advises as follows on this subject:—To prevent a cotton belt from jumping it should be made with a taper joint. This can be done by cutting off plies at different lengths, letting one end overlap the other, and lacing in the usual way.

TELEGRAPH POSTS AT BUCKINGHAM.—At the last monthly meeting of the Buckingham Town Council, attention was called to the unsatisfactory positions in which some of the new telegraph posts had been placed. It was, however, stated that the posts had only been placed temporarily as yet, and that, before they were loaded with the full complement of wires, they would be put in proper position. There were ten on the London road which would have to be shifted.

ELECTRIC LIGHT IN MILLS.—Owing to the high speed at which the various machines are run at Messrs. Ermen and Roby's Mill, Patricroft, near Manchester, the greatest difficulty was experienced to keep anything like a steady light with gas, in fact it was not at all uncommon for the gas jets to be blown out. The Simplex Electric Light and Plant Company has now installed some Müller's incandescent lamps maintained by a shunt-wound dynamo, driven by a small horizontal engine. Among other works that this company has in hand is the lighting of Messrs. J. Robertshaw and Son's mills, near Bradford, and Messrs. T. Ormerod and Co.'s mill, Haslingden.

OVERHEAD WIRES.—At a recent meeting of the Chelsea Vestry, the Committee of Works considered a letter from the St. George's, Hanover-square, Vestry, enclosing a resolution to the effect that they regretted the Government had not seen their way to legislate on the subject. The chairman said Sir Charles Dilke had told him there would be a select committee appointed to inquire into the subject, and the question was adjourned.—The Lewisham Board of Works concurs in the views of St. George's (Hanover-square) Vestry, that the control of overhead wires should be under some adequate

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local authority, and that in the metropolis such authority should be the vestries and district boards.

THE TELEPHONE IN PARIS.—The following classification of the subscribers to the Société Générale des Telephones in Paris was given by the *The Times'* correspondent last Saturday :—Bankers, 234 in 1884, and, owing to the closing of 14 unsuccesful banks, 222 in 1885; brokers, 102; newspapers, 71; printers, 65; cab proprietors, 60; booksellers, 56; engineers, 50; builders, 41; stockbrokers, 37; publicists, 30; clubs, 27; architects, 27; restaurants, 26; railway companies, 26; hatters, 22; insurance companies, 21; barristers and solicitors, 21; hotels, 21; cafés, 21; theatres, 15; dressmakers, 14; Government offices, 9; physicians, 6; Chinese shops, 3; and embassys, 1, namely, that of Russia. The subscribers are charged at the rate of 600f. (£24) per annum.

LAUNCH OF A CABLE STEAMER.—A launch took place at the yard of Messrs. R. Napier and Sons, Govan, on Monday, the 19th inst., of a steamship designed for laying down, picking up and repairing submarine cables for the Eastern Telegraph Company. As the vessel slid into the river she was named the "Electra" by Mrs. R. W. Renwick, of Glasgow. The ss. "Electra" might be called a sister of the ss. "Magneta," which was launched exactly a month ago, on the 19th of December, for the Eastern Extension, Australasia, and China Telegraph Company, being of similar dimensions. The ship is 230ft. in length by 32ft. in breadth, and has 24ft. depth of hold. She is built of steel, and was designed by Mr. Joseph Birnie, of London. We hope to illustrate and fully describe this vessel in an early number.

RIVER PLATE TELEPHONE COMPANY.—The shareholders of the River Plate Telephone Company and the Consolidated Telephone Company will doubtless be glad to hear that the manager of the former company, while on a short visit to England on business matters, reports that it is doing very well indeed, that all the leading people of Buenos Ayres are on the exchange, and that the Government uses the Gower-Bell instrument in preference to the Bell and Blake. The latest returns show 1,300 paying subscribers in Buenos Ayres, and a large increase in Monte Video since the company reduced its rates for subscribers to meet the opposition tactics; and no doubt this increase will be maintained, as the Gower-Bell instrument is fully appreciated in the Argentine Republic, and it was solely the higher rates which drove the subscribers away.

CABLE TO THE WEST COAST OF AFRICA.—In view of the desirability of providing a means of communication by telegraph between Great Britain and the British Settlements and Protectorates on the West Coast of Africa, the Government is prepared to recommend Parliament to grant a subsidy to a contractor for laying, maintaining, and working a submarine telegraph cable from St. Vincent (Cape Verde Islands) to Bathurst, Sierra Leone, Accra, and thence to a place along the coast not further east than Victoria Settlement in Ambas Bay, either direct or touching *en route* at Lagos, or touching *en route* both at Lagos and at a point on the Niger. The last day for the reception of tenders is Thursday, the 12th prox.; they must be enclosed in sealed covers, marked "Tender for West African Cable," must be addressed to the Secretary, General Post Office, E.C., and be delivered by twelve o'clock noon on that day. The conditions will be found in our advertising columns.

"THE EVENING SUN."—This is the title of a lecture given by Mr. Eric S. Bruce, M.A., M.S.A., at the Pump Room, Tunbridge Wells, on the 16th inst., and repeated at the Young Men's Hall the following day. The lecturer started from Franklin's experiments, on the locality of which the Philadelphia Electrical Exhibition was afterwards held. He said that electricity was "not matter, but a molecular condition of matter—a species of energy—a mode of motion," and that, to obtain cheaper light from electricity, we must look for improvements in the dynamo and greater efficiency in incandescent lamps. Already the Woodhouse and Rawson lamp required only $2\frac{1}{2}$ watts instead of the usual $3\frac{1}{2}$, thus admitting of 30 per cent. more lamps in the same circuit. The lecture was illustrated by views projected on the screen, and also by many interesting experiments, including the blowing of an incandescent lamp from a glass rod, and the fitting in of its carbon filament.

NEW GUINEA NATIVES AND ELECTRIC LIGHT.—A correspondent who was at the annexation proceedings, writing to the *Register*, says:—"The 'Nelson' was lying at anchor some miles from the village; but, by the aid of her electric light, the huts on shore could be plainly distinguished. Then for the amusement of the natives the siren or fog horn of the 'Nelson' was sounded. The effect was ludicrous in the extreme, the instrument alternately groaning and barking and making the most extraordinary noises. In some instances I was informed the natives thought the two electric lights to be the eyes of some great monster; and, when they heard the sounds of the siren, they immediately concluded that it was the voice of the monster, and numbers of them ran away and hid in the bush in terror. While the illumination was proceeding, the moon rose through a light bank of clouds over the hills, and the electric light and firing off of rockets was one of the prettiest sights that anybody could wish to see."

CANADIAN TELEGRAPHS.—The telegraph system in Canada is in the hands of public companies chartered by Act of Parliament, the largest and most important of these being the Great North-Western Company of Canada, which is formed by the union of the old Montreal and Dominion Companies; and this company has 31,673 miles of wire in operation, with 17,042 poles. The rate in Canada for a message of ten words, address and signature not counted, is 25c. (1s.), and 1c. for each additional word, a message being sent at this rate for a distance of 1,300 miles. The price for special newspaper reports is as cheap as 25c. (1s.) per 100 words; and the actual number of words of newspaper reports received at one city (Toronto), and furnished in one year, is 10,807,668. There are also the Canadian Mutual Telegraphs, while the Government owns some telegraph wires. The telephone system is in very active operation in all the towns of Canada, the city of Ottawa alone, with a population of about 28,000, having about 100 miles of wire in operation.

SOCIETY OF ARTS PRIZES AT THE INVENTORIES.—Among the special prizes (independent of the jury awards) announced by the Society of Arts to be given by it at the forthcoming Inventions Exhibition, are gold medals value £20 each, under the Howard trust, one for the best exhibit in Group 4, Prime Movers, Class 26—steam engines and boilers; one for the best exhibit in Group 4, Class 27—gas and air engines; one for the best exhibit in Group 4, Class 28—means of utilising natural forces; one for the best exhibit in Group 11, Hydraulic Machines, &c., Classes 59 to 62; one for the best exhibit in Group 13, Electricity, Class 72—distribution and utilisation of power; and, under the Fothergill Trust, one gold medal for the most novel and best exhibit in Group 28, Philosophical Instruments and Apparatus, Classes 148 to 158. The council proposes to ask the juries in each class to recommend for their consideration either two or three exhibits which they might consider deserving a prize, and it will not be necessary for any special application to be made in respect of these prizes.

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ELECTRIC LIGHT IN THE PANTOMIME.—At the Theatre Royal, Nottingham, Mr. Thos. W. Charles's pantomime, "The Forty Thieves," has been produced in magnificent style, each of the forty thieves carrying three incandescent lamps—one in the shield, one in the spear, and one in the helmet. With captain and officers this makes 129 lamps, which require 376 elements, while five gallons of solution are consumed at each performance. Each of the forty carries a 9-cell bichromate battery, three cells being used for each of the three lamps. The whole battery measures 8in. by 2½in. by 4in., and the wires are mostly inside the dresses. The connections (486 in number) require to be made quickly and securely, as the changes from one scene to another are very rapid. There are 376 zinc and 752 carbon elements, the carbons being double in each cell. There are also 1,640 electric contacts to be made good before the lamps can be lighted. Messrs. Oppermann Brothers, of London and Chicago, are the makers of the special lamps for the ballet; and the electric room is under the superintendence of their agent, Mr. G. E. Smith, while Mr. T. Willoughby has care of the batteries.

ELECTRIC LIGHT FOR HACKNEY.—At a recent meeting of the Hackney District Board of Works, the General Purposes Committee brought up a report on a letter recently received from the Jarman Electric Lighting Company, asking permission to open certain paths for the purpose of laying mains from their works at Mackintosh-lane, Homerton, to Mare-street, Hackney. The committee recommended that the sanction of the Board be given, subject to the company depositing a sufficient amount to reinstate the paths disturbed, and also subject to a proper agreement being entered into for the protection of the Board. Mr. Compton, in moving the adoption of the report, said that certain tradesmen in Hackney desired to use the electric light; and the committee thought permission should be given, subject to an efficient guarantee being deposited. Mr. Cox contended that, before giving any electric lighting company such power, they should know the means of the company, and what advantages the Board, as a public body, would obtain, as it would be granting this company a monopoly. The report was referred back to the General Purposes Committee to consider what arrangements could be made with the company with a view to light the public lamps in the proposed district.

THE TELEPHONE AT DEVONPORT.—The United Telephone Company has opened an exchange at the corner of St. Aubyn-street and Fore-street, in a good position, and purposes to virtually make the town a present of several free wires in due course. It is intended to connect the Albert Hospital and also the principal cab stands. Subsequently, the principal fire engine station will be put in communication with the exchange, and seeing there is no fire station in connection with any organised system but that of the police, this will, in all likelihood, run to the Guildhall buildings in Ker-street; it is also probable that the Post Office will be connected, thus enabling a subscriber to obtain information and probably to get his telegrams forwarded, as it is understood that any corporate body may subscribe, so that its members could individually use the exchange. Private wires already exist, though not in any great number, being available between any two given points at all times, at the convenience of the users. The company has acceded to the terms which the town desired, with certain reservations as to a term of years. The Devonport Exchange, while being a part of the Three Towns system, is the centre of the town's own system; and it is expected that very shortly Saltash will be in communication with the three towns.

ELECTRIC LIGHT AND POWER COMPANY.—At the Bow-street Police-court last week the Electric Light and Power Company and Messrs. Parrish and Goddard, directors thereof, were summoned by Mr. B. Bouler for an alleged contravention of the Companies Act in neglecting to forward to the Registrar a list of members and a summary of shares for the year 1884. Mr. George Lewis defended. The evidence, which was of a very complicated character, showed that several extraordinary meetings had been held during 1884 for the purpose of winding up the company and for reconstructing it, but that no general meeting had been held within that year. The question raised was whether an extraordinary meeting of the company was to be considered as a general one. Sir James Ingham decided that, under the 26th section of the Companies Act, the proceedings against the company could not be sustained. He considered that an extraordinary meeting was different from the ordinary general meeting as prescribed by the statute. He consequently dismissed the summons, but at the request of the complainant granted a case subject to recognisances to the extent of two sureties in £50 each being procured, in addition to a personal recognisance of £100. On Mr. Lewis applying for costs, Sir James Ingham allowed the defendant company and directors costs amounting to twenty guineas.

TELEPHONE "CALL OFFICES" IN MANCHESTER.—In accordance with the terms of the Postmaster-General's license, the Lancashire and Cheshire Telephonic Exchange Company has adopted a course which will doubtless prove advantageous to the commercial community in particular and the public generally. They have established a number of public "call offices" in Manchester, Liverpool, Blackburn, Preston, and other towns where any person, whether a subscriber or not to the Telephonic Exchange system, may speak to any firm or person on the company's list of subscribers. Offices were opened in Manchester on Monday at the following addresses: Walter Carter, 103, Market-street; T. R. Withecomb, Victoria-street; Grey and Shaw, Chepstow Buildings, Oxford-street; C. Midgley, St. Ann's-square; Dog and Partridge Hotel, Fennel-street; Cotton Waste Exchange, Market-place; Central Telephone Offices, 38, Faulkner-street; Telephone Offices, 57, Brown-street; Telephone Offices, Lloyd's House, Albert-square; Turkish Baths (W. M. Heriott), Stevenson-square; W. Woodruff, 107, Oxford-street, Chorlton-on-Medlock; and Joseph Fielding, Cheetham Hill-road. Other offices will be opened at an early date. The charge for speaking within the limits of any town is 3d. for three minutes or fraction thereof, and 6d. for three minutes if the person spoken to is in another town.

DINNERS TO TELEGRAPHISTS.—We are glad to see that there is a more generous desire growing in the public mind to recognise those who, although in Government employ, transact a great deal of business in the interests of the public generally. At the beginning of the month the telegraphists of Swansea held their annual dinner, at which their services were duly recognised by the various speakers, and last week the members of the staff of the Leicester Postal Telegraph Department held their annual dinner, during the proceedings of which some interesting statistical information was given. Among other things it was mentioned that there was an extension of the telephone work of the town, and that a trunk wire was being constructed between Hinckley and Leicester. With regard to the telegraphic work in 1883 the increase of telegrams in Leicester over the previous year was 19,000, and last year there was an increase of 22,000 over the number in 1883. In 1883 the telephone calls numbered 45,148, in 1884 they reached 57,949; in December, 1883, the calls were 3,531; in

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December, 1884, 6,276, or nearly double. The first fourteen days of the present year the number was 4,297. The largest number of transactions recorded in an hour was 80, the largest number in a day 502—an average of eight for each of the subscribers. Reference was made to overhead wires, and it was stated that in the system pursued in Leicester every possible regard was paid to safety, the best materials were used, and the closest examinations made.

ELECTRICAL CELEBRATION OF NEW YEAR'S EVE.—On New Year's Eve, Mr. Wm. J. Hammer, who superintended the introduction of the Edison light on this side the Atlantic, invited to supper all the "old boys" of the Newark, N.J., High School, "Class of '77," of which he was a member. The members of the class came from all parts of the country to revive the memories of the past, and to witness some novel experiments in electricity. Those who rang the door bell were anxious to let go as soon as possible, as some person had attached an electric wire to the knob. On advancing to shake old classmates by the hand, the new comer accidentally stepped on an electric button, and every light in the house was extinguished. On the lights being again put in circuit, he was requested to take a seat; but he somehow managed to secure a chair that was connected by a wire with other arrangements, and he was surprised to hear bells ring and drums beat in the different parts of the house. The lights were again extinguished, and stars shone from the ceiling, then a skeleton made its appearance and paraded round the room. When the company proceeded to the dining room the lights were again extinguished and the dishes on the table were illuminated by incandescent lamps about as large as a walnut, one of which was given to every one as a *souvenir* of the pleasant occasion. After the new year had been duly ushered in one of the gentlemen was requested to cut the cake, when he found this particular cake to be simply a telegraph instrument, with a number of wires attached, but so ingeniously arranged as to look like a veritable product of the oven.

RATING OF TELEPHONE WIRES.—At the Bristol Quarter Sessions the case of the United Telephone Company *v.* the Bristol Sanitary Authority, being an appeal against the general district rate, was lately heard by the recorder, Mr. C. G. Prideaux, Q.C.—Mr. Poole, for the company, contended, first, that the Telephone Company had no rateable property; and secondly, that the valuation on which the rate had been made was excessive. He pointed out that the assessment to the poor rate was under appeal, on the ground that, if the poor rate was reduced, so must the sanitary rate be. Mr. Philbrick, for the sanitary authority, said that, though any alteration made in the poor rate would affect a sanitary rate made afterwards, it would not affect any intermediate rate; he also observed that there was the question as to whether the company was in possession of rateable hereditament The telephone company in Lancashire appealed to the Divisional Court, which held that the wires were rateable; the company went to the Court of Appeal, and the Master of the Rolls and Lord Justice Lindley dismissed the appeal on the ground that the wires and attachments occupied a portion of the buildings to which they were affixed with so much of the soil as was necessary to support them, and that the company had such exclusive occupation of the land as to make them rateable, when leave was given to appeal to the House of Lords. The sanitary authority was seeking to enforce a public burden for the public benefit, for the public had a right to expect that, if the company was liable to be assessed, it should not be omitted from the rate. The appeal was adjourned to the next Quarter Sessions.

ELECTRIC LIGHT AT A BALL.—A very rapid installation of the electric light was completed last week by Messrs. Woodhouse and Rawson on the occasion of the bachelors' ball which took place at the Crown Hotel, East Grinstead. The interior of the rooms was lighted by incandescent lamps, and the exterior of the building and the High-street by arc lights, which burned with remarkable brilliancy and steadiness, illuminating the street on either side for a considerable distance, the effect being greatly enhanced by the fact that the ground was covered with snow, making it to have all the appearance of daylight. The installation consisted of two Marshall engines of 7 horse-power, two Bürgin machines, 100 Woodhouse and Rawson incandescent lamps, and two Crompton arc lamps of 3,000 candle-power. The whole of the wiring in the house was completed with sufficient care for a permanent installation, the joints being all carefully made and properly insulated. The electroliers, designed specially for the purpose, were completely covered with evergreens, eight being used in the ball room with four lights each, and four in the supper room with eight lights in each, the others being similiarly distributed in the sitting rooms, hall, and passages. The whole of the work was completed in three days, the dynamos only arriving late the night before the ball. In addition to this, a shed 25ft. by 40ft. had to be constructed for covering over the engines and dynamos. The plant was started for the first time at four o'clock on the afternoon of the day of the ball, and ran throughout the ball, which was kept up until 4:30 in the morning, without a break or a stoppage of any sort, giving great satisfaction to all present.

TELEGRAPH AND TELEPHONE WIRES.—On January 15th, at the meeting of the Marylebone Vestry, a report was submitted from the representatives of St. Marylebone at a conference of delegates from the vestries and district boards of the metropolis, convened by the Wandsworth District Board of Works, upon the subject of the future control of telephone and telegraph wires along and over the public thoroughfares. Mr. J. R. Endean, the chairman, brought up and moved the adoption of the report. It stated that the President of the Local Government Board having declared it to be the intention of Her Majesty's Government in the next Session of Parliament to obtain a select committee to ascertain the best mode of dealing with telegraph and telephone wires, the conference unanimously approved of such inquiry being made. They had drawn up suggestions for the Parliamentary Committee based upon the principle that no authority, whether existing or to be created, is or can be better qualified to govern and control all wires, whether laid or elevated, than the existing local authorities. First, that they are the only existing authority by and under whom all matters connected with the streets and thoroughfares are governed; secondly, they have recently proved that they are not only qualified but are fully prepared duly and efficiently to discharge all duties connected with telegraphs and telephone systems that future legislation may require at their hands; thirdly, the creation of a new and independent power for these wires only would be certain to create unnecessary and undesirable friction between district authorities, with no beneficial result, and that instead of the creation of a new governing body for such purpose only, all functions required could be discharged readily by the existing street authorities without any material cost to the ratepayers. The report further recommended that the Metropolitan Board should be the first Court of Appeal.—The adoption of the report having been seconded, Admiral Oliver and Mr. Sedgwick objected to the second paragraph as being too self-laudatory and arrogant, and moved as

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an amendment that it be expunged; but on being put it was negatived, and the adoption of the report carried by a large majority.

SHIP LIGHTING.—Messrs. John Elder and Co. have just launched, for the New Zealand Shipping Company, a steel screw steamer, a sister vessel to the steamship "Kaikoura," launched in September last. The principal dimensions of the vessel are as follow:—Length between perpendiculars, 420ft.; length over all, 451ft.; depth, 33ft. 4in.; with a gross tonnage of about 4,500 tons. The engines will indicate about 4,000 horse-power, are compound surface-condensing, with two inverted cylinders, one high-pressure 46in., and one low-pressure 88in. diameter, adapted for a stroke of 4ft. 7in. The high-pressure cylinder has a valve of the equilibrium-piston type, and the low-pressure cylinder has an ordinary double-ported side valve. These valves are worked by the usual double excentric and link motion. The propeller blades are of manganese bronze, with which material the blades can be cast with fine edges and a smooth surface. The steam is supplied to the engines by three cylindical double-ended multitubular boilers of steel, to be worked to 110lb. pressure per square inch, having in all 18 of Fox's patent corrugated furnaces. Accommodation is provided for 87 first-class passengers on main and spar decks. There is also accommodation for 82 second-class passengers on the main deck, and for 250 third-class passengers forward. The state rooms, which are unusually large, will be fitted with all that can add to the comfort and convenience of the passengers for a long voyage. The main saloon is in the mid-ship portion of the ship, immediately abaft the engine room, and will be a large, elaborately-furnished apartment 42ft. by 32ft. Over the centre of the saloon is a well, 18ft. by 12ft., with a large pavilion skylight on the hurricane-deck above, giving ample ventilation, and making the total height of the saloon fully 17ft. The ladies' boudoir, which is fitted immediately abaft the saloon, will be finished in a handsome manner. The saloons, entrances, corridors, ladies' room, smoking room, card room, state rooms, engine and boiler room are all fitted throughout with the electric light on the incandescent principle; but independent of the electric light the vessel is provided throughout with oil lamps of the most improved principle. The greatest care has been taken in the lighting, ventilating, and sanitary arrangements.

"ABUSE OF THE TELEGRAPH."—The Committee of the Stock Exchange, according to the *Standard*, decided on the 19th inst. to expel the Exchange Telegraph Company from the interior of the building, and three months' notice will accordingly be given to determine the company's tenancy. On this the *Pall Mall Gazette* remarks that the "jobbers," who are the real mainstay of gambling on the Stock Exchange, have succeeded in their agitation to remove the "tape," which, by making known close prices to the public, was an inconvenient impediment to their operations. That a respectable body like the Committee of the Stock Exchange should thus have given way to an agitation which, in plain English, is nothing more nor less than a demand for increased facilities for gambling and befooling the public, will surprise most sensible people. *The Times* says:—"Altogether, we do not see that anyone will lose materially by the decision of the managers in this matter, but neither do we think that any important advantage, public or private, will be gained by it." The *Daily News* says:—"Were the tape' instrument to remain within the House the committee could obviously keep some control over it; but having issued a decree of banishment, it loses all such control, and the tape agency will be at liberty to cut out the jobbers." This it purposes doing straight away by acting on the suggestion of the Royal Commission—namely, by making use of the telephone and the tape to bring buying and selling brokers together without the intervention of the jobber. Immediately on this decision, the Exchange Company issued a circular explanatory of their action, stating among other things, "As some misconception appears to exist in regard to the nature of the plan proposed by this company to facilitate business in 'non-current' stocks by means of our recording instruments, we beg to address you on the subject. It is intended by means of the 'tape' to announce instantaneously and simultaneously to all subscribers, being members of the Stock Exchange, that particular subscribers, also members of the Stock Exchange, are desirous of dealing in particular securities. The method contemplated is simple. A particular broker, being a buyer or seller of a security in which he can get no 'business' price made, and wishing in the interests of his client to find out a real seller or a real buyer, will instantly communicate to this office by telephone (which is already provided with the recording instrument) the fact that he is a dealer in such security. This announcement will be forthwith transmitted to every subscriber by affixing the broker's telephone number to the name of the security specified on the tape. By this means, within a minute and without leaving his office, it will be possible for a broker to lodge a 'notice' of his requirements at the office of every other broker in the Stock Exchange. By the mechanical combination of the 'tape and telephone' it will thus be seen that the physical obstacles of time and space in the constitution of the market are reduced to the minimum. The same result will be obtained as if every member had been personally addressed in the matter, but without the expenditure of the time and exertion occupied in so doing, and with the additional advantage that the intimation will of course bind no one. There are no other means available of securing the same results. Apart from the delay and difficulty incidental to posting 'notices' on the 'pillar,' as described in the Minutes of Evidence taken before the Royal Commission, or the trouble which would be involved in making an 'entry' in a 'register,' such as was suggested in the commissioners' report, it is obvious that a 'notice' when posted, or an 'entry' when made, must be in the nature of the case local, whereas the announcement made in the manner herein described will be widely disseminated. It is not possible to form an adequate opinion of the benefit of this plan in the absence of actual experience, but it has had the favourable consideration of economists as well as men of business, and we submit with confidence that its adoption will be attended by the most satisfactory results. We are not, of course, insensible of the fact that such a system will appear to prejudice certain interests, but we are convinced that the facilities for the transaction of the public business thus afforded will do more than anything else to establish confidence in the Stock Exchange, to the benefit of the general body of members. We think you will agree with us that if you are enabled to offer your clients the same advantages in the execution of their orders as would result from an amount of industry which would be physically impossible, it would conduce to your success, and that such a system in the hands of any outside organisation would constitute an irreparable injury to the market of which you are a member. I will not enter upon the general question of the 'tape,' further than to say that it is now, as ever, the wish of my directors, in all their arrangements, to be in accord with the Stock Exchange, and to take any steps which may be held to further the interests involved."

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CHARLES ERNEST SPAGNOLETTI.

SPAGNOLETTI, CHARLES ERNEST PAOLO DELLA DIANA; born 1832, at Brompton, was educated at Blennell House, Brompton. On commencing active life, in 1846, he was engaged for a short time in the National Debt Office, and afterwards took an appointment under Mr. Alexander Bain, the inventor of the Chemical Printing Telegraph, with whom he worked until the Electric Telegraph Company opened their central station at Founders-court, Lothbury, in January, 1847, when he commenced his service with that company, representing them in several towns in England, until he entered the service of the Great Western Railway Company, in 1856, as chief of the telegraph department, where he at once began to organise a system, drawing out a book of rules and special codes to meet the requirements of railway telegraphy, which laid the foundation of the regulations now in use on every line in the kingdom, and he has been aptly termed "Father of Railway Telegraphy." The success of his efforts was such as soon to induce other railway companies to follow the example of the Great Western Railway in forming a telegraph department of their own for working their line, instead of leaving it in the hands of the then Electric Telegraph Company, who had hitherto performed these duties for them. When the Metropolitan Railway, in 1865, was opened, it was worked by the Great Western Railway, and in order to meet the requirements of an anticipated heavy traffic and quick succession of trains, Mr. Spagnoletti brought out, in 1862, his disc block instrument for controlling the traffic of this line, and drew out the regulations therefor. On the opening of the District Railway the same system was adopted, as also upon the Great Western Railway, and some other railways at home and abroad. He also arranged this instrument to work on the 1, 2, and 3 wire systems. Finding the effects of lightning were exceedingly dangerous to the working of the block system, by weakening, neutralising, and reversing the signals, he next invented his induced coil, which entirely removed these dangerous results; and this invention is now generally used in all needle instruments, its advantages being so manifest that all railway companies using needle instruments have adopted it. Keeping his attention to improvements in railway working by electrical appliances, he introduced an instrument to indicate to signalmen the position of the "semaphore arm" which they work, when from various causes it is out of the sight of the signalman working it, and also an apparatus for showing him whether the signal lamp is "in" and burning properly or "out" at such signals. He also designed, in the year 1868, a large telegraph board for Ascot racecourse, showing the starters in and winners of the races. This is electrically worked from the weighing room and judge's box, about half a mile distant. This at the time was the largest piece of electrical machinery ever made, and was designed at the request of the Earl of Cork and Orrery, Master of the Buckhounds, with a view of dividing the crowd, which was yearly increasing, and as the rush to obtain the numbers was getting serious.

Mr. Spagnoletti has also patented many other important improvements, such as electrical signals, electrical appliances for working drawbridges over rivers and docks, so that no train can be signalled and allowed to pass over it until these bridges are in proper position; also a system for electrically locking the signal and point levers, so that the signalman at the station in advance may control (as regards sending trains forward) the working of the signals at the station in the rear; and for controlling immediate sidings, drawbridges, &c., and adding to the safety of railway travelling both on double and single lines. The trains by this system performing part of the working themselves, controlling and checking the signalmen; locking block instruments of various kinds; a system of various fire alarms for towns, districts in large cities, and for lunatic asylums and other large establishments; also an electrical bell, by which any number can be worked and kept ringing on a single line wire; an electric tell-tale clock for asylums, by which a record is made of every visit paid throughout the night to each room or particular spot appointed, showing the duration of the visit, and the time occupied in getting from one room to the other. This clock is also applicable to railway signals, so that the exact time a signal arm is either at danger or all right is recorded, and the register can at any time be examined. In the year 1873 he brought out a polarised relay, and in 1881 patented a dynamo electric machine and communication between passengers and guards.

He is President of the Society of Telegraph Engineers and Electricians, a member of the Institution of Civil Engineers, and also member of the Society of Arts, the Dynamicables, and other institutions. He was a juror of the Paris Exhibition in 1878 for the Electrical Department, and member of the Congress and exhibitor at the Electrical Exhibition of Paris, 1881, and received a silver medal; also juror and exhibitor at the Electrical Exhibition at the Crystal Palace, 1882, and on the General Committee and juror of the Electric Lighting Department of the International Health Exhibition of last year.

He has been for 28 years chief electrician and telegraph engineer of the Great Western Railway, and has led an active and practical life in the development of electrical appliances for the working of railways and in electrical science generally.

On Thursday last Mr. Spagnoletti delivered his inaugural address to the Society of Telegraph Engineers, and although, in the nature of things, we have to write before the delivery of the address, we may venture to think that whatever Mr. Spagnoletti has to say will bear favourable comparison with the remarks of his predecessors.

It is no mean task that the President of the Society of Telegraph Engineers and Electricians has to perform in following in the footsteps of masters both in the theory and in the practice of electricity. We do not know if in the selection of President it is intentional to alternately select a theorist and a practical man. This, however, has been the case during the past few years. Thus Professor Adams succeeded Mr. Willoughby Smith, whose life has been spent in practical work, and is succeeded by Mr. Spagnoletti, another exponent of practice. The society should make itself the centre of electrical progress, and we feel assured that this new President will be heartily supported in all his endeavours to add to the usefulness and lustre of the society.

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ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 180.)

Real transient, and suggested dissipative Magnetic Current.

As the rate of increase of the displacement in a non-conducting dielectric is the electric current, so the rate of increase of $B/4\pi$ may be called the magnetic current. Let it be G. Then

$$G = \frac{1}{4\pi}\dot{B} = \frac{1}{4\pi}\mu\dot{H} \quad \text{. . . (Magnetic current) . . (12).}$$

Like displacement electric currents, magnetic currents are transient only, *i.e.*, they cannot continue indefinitely in one direction, like a conduction electric current. Also, like electric currents in a dielectric, they are unaccompanied by heat generation. In ether, the electric current and the magnetic current are of equal significance.

There is probably no such thing as a magnetic conduction current, with dissipation of energy. If there be such, analogous to an electric conduction current, then let

$$G = gH + \frac{1}{4\pi}\mu\dot{H} \quad \text{. . . . . (13).}$$

Here gH is the magnetic conduction current, which, added to the undoubted magnetic current as in (12), gives G the true magnetic current. g may be scalar, or similar to k, with rotatory ϵ. Multiply by H. Then, using (11),

$$HG = HgH + \dot{T} \quad \text{. . . . . (14).}$$

Here HgH is the rate of dissipation. Compare with (9).

Effect of g in a Closed Iron Ring.

The permanency of state of a steel magnet makes it improbable that g has any existence at all, and that the conduction magnetic current is quite imaginary. But we may inquire what would happen in a closed ring of iron under magnetising force, on the supposition that g exists. Let the ring be uniformly lapped with wire, through which we pass a current from a voltaic battery.

If the radius of the ring be large compared with its section, the core may be treated as straight, and the manner in which the current would rise in the coil and the accompanying core phenomena easily worked out by a slight modification of the corresponding case with $g = 0$ (*Electrician*, Sept. 6, '84, Ex. 2). Let a be the radius of the core, also of the coil of negligible depth surrounding it, having N windings per unit length of core. Let k and μ be the conductivity and permeability of the core, and H (parallel to the axis) the magnetic force at distance r from the axis. The differential equation of H will be

$$\frac{1}{r}\frac{d}{dr}r\frac{dH}{dr} = (4\pi)^2 gkH + 4\pi k\mu\dot{H};$$

whence $J_0(nr)e^{mt}$ is a normal system of magnetic force, if

$$-m = \frac{n^2}{4\pi k\mu} + \frac{4\pi g}{\mu}.$$

Thus the effect of g is to increase the reciprocal of the time constant of every normal system by the same quantity $4\pi g/\mu$; in this respect resembling the effect of uniform leakage along a telegraph line, and having a similar result, viz., to accelerate the establishment of the permanent state. When this is reached, we do not have uniform strength of magnetic force in the core; but, if H_0 is the strength at the axis, that at distance r therefrom is

$$H = H_0\left(1 + \frac{xr^2}{2^2} + \frac{x^2r^4}{2^2 4^2} + \dots\right),$$

where $x = (4\pi)^2 gk$. This is accompanied by core currents parallel to the coil current of density

$$-\frac{1}{4\pi}H_0\frac{xr}{2}\left(1 + \tfrac{1}{2}\frac{xr^2}{2^2} + \dots\right).$$

The coil current will be a little less strong than if $g = 0$; for the work of the battery is spent not merely in supporting the coil current, but in heating the core both by reason of the weak core electric current, and the supposed weak magnetic current gH. The back E.M.F. in the coil will be of strength

$$-F\left\{1 + \frac{R}{4\pi Lg}\frac{1 + \frac{xa^2}{2^2} + \dots}{1 + \frac{1}{2}\frac{xa^2}{2^2} + \dots}\right\}^{-1},$$

where F = E.M.F. of battery, R resistance of coil circuit, and L its coefficient of self-induction without the core—*i.e.*, with air replacing it. Or, since g is to be small,

$$-F(1 + R/4\pi Lg)^{-1}.$$

If $L/R = \cdot 01$ second, $g = 1/4\pi$ would make the back force $= 1/101$ of the battery force, so g, if existent, must be very small.

In the following $g = 0$, so that equation (12) is the equation of the magnetic current.

Cross Connections of Magnetic and Electric Force.

In the foregoing we have been dealing with the direct connection of the electric force and its consequences, electric conduction current and displacement, and of the magnetic force and magnetic induction. We have also brought in the displacement current in a dielectric, and the true current in a conducting dielectric. Also, to balance the displacement current, we have introduced the magnetic current. But so far we have no relations whatever between the electric and the magnetic quantities, which we must have, in order to make a consistent system.

The first cross connection is expressed by

$$\text{curl } H = 4\pi\Gamma \quad \text{. . . . . (15)}$$

H being the magnetic force and Γ the true current. Here "curl" is, like sin and cos, the symbol of an operation. It is so recurrent in electro-magnetism that it may be termed *the* electromagnetic operator. It may be defined with reference to Cartesian co-ordinates thus: If H_1, H_2, H_3, are the three rectangular components of H, those of curl H are

$$\frac{dH_3}{dy} - \frac{dH_2}{dz}, \quad \frac{dH_1}{dz} - \frac{dH_3}{dx}, \quad \frac{dH_2}{dx} - \frac{dH_1}{dy}, \quad \text{. . . . . (16)}$$

But the most useful definition is that which is virtually contained in the fundamental Theorem of Version:—The line-integral of a vector H round any closed curve or circuit (or the "circulation" of H) equals the surface integral of another vector, viz., curl H, over any surface bounded by the circuit. Apply this to small squares in planes perpendicular to x, y, and z successively, and the three expressions given in (16) for the components of curl H follow at once. Apply the theorem to suitably chosen infinitely small areas in any system of co-ordinates and we obtain the proper expressions in usually a far simpler manner than by laborious transformations of differential coefficients. Whilst the expressions for the components vary according to the system of co-ordinates chosen as most suitable for a special problem, the theorem, on the other hand, is universal, and gives us the inner meaning of the operation. It is far the best in general investigations not to employ any system of co-ordinates, but to emancipate one's self from their complexity by employing symbols which only relate to the intrinsic meaning of our operations; besides which there is a great gain in the ease of manipulation. In the present paper the meaning of all forms of expression likely to be unfamiliar are briefly stated, and we shall avoid occupying valuable space by lengthy formulæ.

The operator "curl" is connected with rotation thus: if H be the instantaneous velocity at a point in a moving fluid, curl H is a vector whose direction is that of the axis of instantaneous rotation of the fluid surrounding the point, and whose length equals twice the angular velocity of rotation.

Notice that (15) contains no physical constants. It is therefore, in a sense, a purely geometrical equation. Given a system of magnetic force H, mentally represented by lines or tubes of force mapping out space in one way, by the operator "curl" we find another system of lines or tubes mapping out space into another way, viz., the current lines and tubes. Whether

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H be wholly continuous or not, the derived Γ is necessarily continuous. The curl of a vector can have no divergence anywhere, which we express by

$$\text{div}\Gamma = 0\ ;\ \text{or,}\ \frac{d\Gamma_1}{dx} + \frac{d\Gamma_2}{dy} + \frac{d\Gamma_3}{dz} = 0, \quad . \quad . \quad (17)$$

which defines "divergence" with reference to Cartesian co-ordinates. The divergence of Γ is the amount of Γ leaving a point reckoned per unit volume. When Γ, as here, signifies electric current, it is continuous; as much current leaves as enters any volume, or the integral amount leaving it, reckoning that entering it as negative, is zero. That (17) is involved by (15) is tested by differentiating the three components in (16) to x, y, and z respectively and adding them, when (17) results.

Given H, we have Γ by (15) perfectly definite. But given Γ (necessarily continuous), H is not definitely fixed by (15). For, on finding one function H satisfying (15) with Γ given, we may add to H any function I such that curl I = 0, without disturbing the relation (15). The nature of I is given by

$$\mathrm{I} = -\nabla\Omega;\ \text{or,}\ \mathrm{I}_1 = -\frac{d\Omega}{dx},\ \mathrm{I}_2 = -\frac{d\Omega}{dy},\ \mathrm{I}_3 = -\frac{d\Omega}{dz}, \quad . \quad . \quad (18)$$

when Ω is a *scalar* function of position, a scalar potential in fact. We require some other condition than (15) to find H completely when Γ is given; this is, that the magnetic induction $\mathrm{B} = \mu\mathrm{H}$, (equation 10) is continuous, or $\text{div}\mathrm{B} = 0$. H is now perfectly definite. If μ = constant, all space equally magnetisable isotropically, then B is the same multiple of H everywhere, hence $\text{div}\mathrm{H} = 0$, so that the proper solution of (15) is that function H satisfying (15) which is continuous, like Γ. But H is not continuous when μ varies from one part of the field to another.

Having now defined "curl," "divergence," and ∇ applied to a scalar function, consider (15) from a less abstract point of view, in the light of the Version Theorem. Let there be any closed circuit in space, whether passing through conducting or dielectric matter is immaterial. The amount of current passing through the circuit in the positive direction (that passing the other way being counted negative) equals the circulation of H round the circuit $\div 4\pi$. The actual distribution of Γ is got by taking the circuit infinitely small and applying it to all parts of the field. Let us, whilst considering a finite circuit, yet take it sufficiently small to make the current pass all one way through it. Then, setting up current through the circuit, we set up magnetic force round it.

But there is another way of setting up magnetic force round the circuit, viz., by motion of the circuit itself in a previously undisturbed electric field. Thus, let there be a steady field of electric force, say in air, with therefore steady electric displacement, and no electric current. Let the closed circuit be a thin wire. When at rest in the field there is no current through it, and no magnetic force round it. But if we move the circuit so that the amount of electric displacement through it varies, there is electric current through the circuit, to be measured by the rate of increase of the amount of displacement through it at any moment; or, in another form, by the number of tubes of displacement added to the circuit per second by the motion of the circuit across them. Hence there will be magnetic force round the circuit, and if it be a thin iron wire, it will become magnetised by the motion in the electric field. In general, the motion of matter in an electric field sets up magnetic force.

As an example, fix a thin circular iron ring in air. Call the line through its centre perpendicular to its plane the axis. Let there be no current or magnetic force in the first place. Now shoot a small bullet, having an electrical charge, through the ring, along its axis. The electric displacement due to the charge will be continually changing; thus, there is a system of electric current in the air accompanying the motion of the bullet. The velocity of propagation of disturbances in air is so great that, unless the velocity of the bullet be *not* a very small fraction of the velocity of propagation, we may neglect the disturbance in the field of force due to the latter velocity not being infinite, and suppose that the bullet carries with it in its motion its normal field of force (radiating straight lines) unchanged. The distribution of displacement current about the moving bullet is then the same as that of the lines of magnetic force that would come from it if it were uniformly magnetised parallel to the axis, or line or actual motion in the real case, and the lines of magnetic force accompanying the displacement currents are circles centred upon the axis, in planes perpendicular thereto, the strength of magnetic force in the air being inversely proportional to the square of the distance from the centre of the bullet and directly proportional to the cosine of the latitude, the equator being the circle on the bullet's surface in the plane perpendicular to the axis passing through the centre of the bullet. (With very high velocity this distribution of displacement current and magnetic force is departed from.) The fixed ring coincides with the lines of magnetic force during the whole motion of the bullet, and is therefore solenoidally magnetised thereby, most strongly when the magnetic force is strongest there, *i.e.*, when the bullet has just reached the centre of the ring, and the current through the ring is a maximum. The current through the ring may be measured either by the displacement current through a surface bounded by the ring, or by the rate at which the ring cuts the lines of electric force (supposed undisturbed) of the bullet.

Next, fix the charged bullet and move the ring instead, so that their relative motion shall be as before. There is exactly the same amount of electric displacement through the circuit added per second as before, in corresponding positions of the bullet and ring, with, therefore, the same magnetic force in the ring and the same magnetisation. Otherwise, however, there is a great difference in the two experiments. In the first case, changing electric displacement or electric current all through the dielectric, the greatest strength of current being at the poles of the bullet; whilst in the latter case the field is practically undisturbed except near the moving ring itself. Compare with the induction of electric force in a ring in a magnetic field first when the field is moving, and next when the ring is moved in the field.

The induced magnetic force per unit length in a wire moved perpendicularly across the lines of force in an electric field equals the amount $\times 4\pi$ of electric displacement of the field crossed by the unit length of wire per second, and is perpendicular to the electric displacement and to the direction of motion. In general,

$$\mathrm{H} = \mathrm{V}\mathrm{D}v \times 4\pi,$$

where D is the displacement of the field, v the velocity, H the induced magnetic force, and V is as in equation (3). There are, of course, corrections due to the reactions set up, due to wire not being infinitely thin, and to finite length.

In electro-magnetic units c in air $= (v_1)^{-2}$ if v_1 = velocity of propagation $= 3 \times 10^{10}$cm. per sec. Therefore, in the case of motion of a thin wire perpendicularly across the lines of force in a uniform electric field of strength E,

$$\mathrm{H} = \mathrm{E}v(v_1)^{-2} = \frac{\mathrm{E}v}{9 \times 10^{20}}$$

Let $\mathrm{E} = 10^{12}$ c.g.s., or 10^4 volts per cm., which is less than the disruption force in air in its ordinary state, then

$$\mathrm{H} = \frac{v}{9 \times 10^8}$$

To get magnetic force of strength 10^{-5} c.g.s., v must equal 90 metres or 300 feet per second.

Magnetic Energy of Moving Charged Spheres.

In passing, I may remark that J. J. Thomson (*Phil. Mag.*, April, 1881) found the magnetic energy $\Sigma\mathrm{T}$ due to a sphere of radius a with an electric charge q moving with velocity v in a medium of permeability μ to be

$$\Sigma\mathrm{T} = \frac{2}{15}\frac{\mu q^2 v^2}{a}$$

I find that the $\frac{2}{15}$ should be $\frac{1}{8}$. Also, he found the mutual magnetic energy $\Sigma\mathrm{T}_{12}$ of two infinitely small spheres at distance r with charges q_1 and q_2, moving with velocities defined by the

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rectangular components u_1, u_2, u_3, and v_1, v_2, v_3, with u_1 and v_1 the velocities parallel to the line joining the spheres, to be

$$\Sigma T_{12} = \frac{\mu q_1 q_2}{3r}(u_1 v_1 + u_2 v_2 + u_3 v_3),$$

against which I find it to be

$$\Sigma T_{12} = \frac{\mu q_1 q_2}{2r}(2u_1 v_1 + u_2 v_2 + u_3 v_3).$$

I do not know what corrections, if any, have been published, and should be glad to receive information on the point, whether in corroboration of my results or otherwise.

(TO BE CONTINUED.)

TEST OF EDISON-HOPKINSON DYNAMO FOR 250 AMPERES AND 55 VOLTS.

The dynamo is of the latest Edison-Hopkinson type with a short armature. The exterior dimensions are :—Length, 56in.; breadth, 36in.; and height, 60in.; and the nett weight of the machine complete is 32cwt.

The commutator is of copper with mica insulation, and has 40 bars, and is provided with double brushes independently adjustable. The magnets are shunt wound.

Magnet resistance is	7·54 ohms.
Armature „	0·009 „

The dynamo is designed for a continuous load of 250 amperes and 55 volts, and to run at a speed of 900 revolutions per minute.

The efficiency of the machine is deduced from the following figures :—

	Watts	H.P.
Total electrical power developed =	16,246 =	21·78
Loss in magnets ..... =	401 =	0·54
Loss in armature ..... =	720 =	0·96
Power available in outer circuit when run as in test ..... =	15,125 =	20·28

Hence—

Electrical efficiency ..... =	93·1 per cent.
Loss in magnets..... =	2·4 „
Loss in armature ..... =	4·5 „

The following are particulars of the test to which this machine has been subjected :—

The dynamo was arranged for driving by an ordinary strap from a double cylinder engine made by Mather and Platt, and carried on slide rails to permit of the belt being tightened if required. One of Sir William Thomson's graded potential galvanometers was permanently coupled to the machine to give a continuous indication of the electromotive force between the terminals, and arrangements were made for measuring the current by means of a current galvanometer, also of Sir William Thomson's graded type.

The temperatures of the bearings were measured throughout the test by means of thermometers placed in mercury cups attached to the bearings, and a continuous record was kept of the temperature of the room.

The speed was indicated by a tachometer attached to the engine, and the revolutions of the dynamo counted from time to time with a counter.

The load was maintained constant throughout the test, as nearly as possible at 275 amperes and 55 volts, measured at the terminals. This is 10 per cent. above the normal load for which the machine is intended.

The machine was started on December 30th and run for five hours, when the temperatures were taken as follows :—

	°C.		°C.
Room.....	17	Magnets	33
Pulley bearing	35	Armature	76
Commutator bearing	36	Commutator...	70

At the end of twelve hours' run the temperatures were again taken.

	°C.		°C.
Room	20	Magnets	33
Pulley bearing	36	Armature	84
Commutator bearing.	34	Commutator...	75

Again, at the end of twenty-four hours, the temperatures were :—

	°C.		°C.
Room	15	Magnets	33
Pulley bearing	30	Armature	76
Commutator bearing.	29	Commutator...	74

Showing that at the end of twelve hours the maximum temperatures had been reached in all parts of the machine. Subsequently, throughout the entire run of three weeks' duration the temperatures did not vary more than was accounted for by variations in the temperature of the room.

The speed maintained throughout the run varied from 910 revolutions to 925 revolutions, with the full load, and the armature and magnets warm.

The machine was run continuously, stopping ten minutes daily to read the temperatures of the armature and commutator, and for Sunday, until January 6th, when it was stopped in order to take out the armature and have it examined to determine if there were any sign of charring or deterioration in the insulation of the wire, and in order carefully to examine the commutator. The examination was conducted by Mr. Blackburn, on behalf of the Edison and Swan United Company, and no change whatever was observable either in the insulation of the wires of the armature or in the commutator.

It was then decided to run the machine absolutely continuously for a fortnight without any break whatever with the full load of 275 amperes. This test concluded on January 20th.

Throughout the whole of this continuous run of fourteen days there was never the slightest sparking at the commutator, the bearings and magnets remained at a uniform temperature throughout, and the temperature of the commutator at the end of the run was 79° C., practically the same temperature as at the end of 12 hours. One set of brushes was used without change of adjustment for twelve days, and at the end were found to be worn down uniformly $\frac{1}{16}$in.

The commutator was perfectly smooth, and showed no signs of wear or grooving, and the armature had stood the run without the slightest swelling or any sign whatever of change in the insulation.

These tests were undertaken by Messrs. Mather and Platt at the request of the Edison and Swan Company, in order to show the durability of the Edison-Hopkinson dynamo under a long and continuous strain, with a load 10 per cent. in excess of that for which the machine is sold. The conditions of the test were formulated by Mr. Albright and Mr. Blackburn, on behalf of the Edison and Swan Company, and it was superintended by them and their representative, Mr. Creagh, during the entire run.

It proved conclusively that a dynamo of this type may be run continuously without any change in its working parts, or deterioration in the insulation of the copper conductors, or change in their resistance, and that the wear is exclusively confined to the commutator and copper brushes, and that with regard to the former, three weeks' run is not sufficient to produce any visible wear, and that the brushes last much longer than usually supposed, one set of them being capable of lasting quite a year on a machine running on an average three hours every day.

ATLANTIC CABLE BROKEN.—The "French Atlantic" Cable broke down on Thursday, a short distance from land. This is the third Atlantic cable that has come to grief on the other side of the water, in about the same neighbourhood, within the last few months.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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THE PUBLIC AND THE TELEPHONE.

Some half playful and wholly innocent observations of ours in *The Electrician* "Summary" for 1884 have, it appears, attracted more attention than we had any reason to suppose they merited. In chronicling a few simple and well-known facts with regard to the Post Office, and its excellent but not numerous telephonic systems, we are accused of being official apologists; and in expressing our opinion that users of the telephone would be better served by a State monopoly, we are, in another quarter, charged with advocating a dog-in-the-manger policy. We may as well dispose of this latter imputation at once by citing the words which have provoked it. We said that "if we had the framing of a policy with regard to the telephonic interests of the country, we would suggest the compulsory purchase of private interests by the State, the extension of underground wires, the lowering of rates, and the opening of every telegraph office as a telephone office." We should have thought this programme radical enough even for the *Pall Mall Gazette*; but our contemporary, although continually advocating State interference in matters of its own choosing, is apparently all for disunion and unrestrained competition when the Telephone Companies are in question. Lowering of rates, extensions such as we cannot hope for under present conditions, and the stoppage of the overhead wire nuisance, are apparently not to be sought for at the cost of a State monopoly. "We have had a lesson of the dog-in-the-manger policy which results from State monopoly," says the *Pall Mall* critic, "in the *telegraphs!*" And so we have—the lesson, indeed, that State monopoly has resulted in our telegraph system being in all respects far ahead of every other system of telegraphs the world over. The *Pall Mall* is not satisfied; neither are we. But this is fact; and as far as it goes it proves that our one dog is a more useful animal than anybody else's whole pack.

But to turn to particulars. We are asked to remember that "invention flourishes best when fanned by keen competition;" and this being so, most people will prefer that "commercial freedom and a healthy competition should rule the roast longer yet." Well, if they really prefer the confessedly inadequate and utterly unorganised systems which are growing up under this healthy competition, we have nothing more to say. We spoke in the public interests; if the public are satisfied we have been grossly misinformed, which we decline to believe; and if the shareholders are content with the prospect before them, we have a very poor opinion of their commercial health. But we think better of their business capacity than to suppose they will long care to hold on to a system which under any conditions possible in the circumstances of this country must result either in retracing their steps at a ruinous outlay or in the compulsory purchase which their newspaper friends profess to deprecate. We have no desire to hurry matters; and the fact that the Post Office has the sixpenny tariff to deal with in the present year ought to have saved the *Edinburgh Courant* from the blunder that we were echoing the official mind. We do not so much as know what the official mind is; but we do know what a telephone is; and when the *Pall Mall Gazette* asserts that invention flourishes best when "fanned by keen competition," and inferentially that the telephone has flourished best under the fanning influence of rival company competitors, it talks as "One who knows" not. Our contemporary over the border argues that because the record of postal telephonic extension is meagre that it is imperfect. We should have thought that the more meagre it is the better the companies would like it; but any stick is good enough to beat the official dog. The quality of the official system, however, is another matter, and tested by evidence which is public property, and has never been disputed, the telephone systems installed and managed by the Post Office are models which it would greatly benefit the public at large if the companies would follow. Had it been otherwise we may be sure official customers, who are not official apologists, would have let us know it.

On one point the *Edinburgh Courant* has misunderstood us. When we said the demand for telephonic extension was "not very pressing," we were speaking of the Post Office. If the demand for postal interference in this line of business is, contrary to what we asserted, very pressing, or at all pressing, the accusation against that department would be that the public, turning from the good services of the companies, demand of the Post Office telephonic facilities which it declines to give. We have never heard of this complaint; and as the *Courant* does not give it that shape, we may infer that there is no ground for it. What, then, does the *Courant* want? It derides the Government's lack of enterprise with one breath, yet with the next denounces our suggestion that the Post Office should extend its enterprise to the whole system. Competitive enterprise is—we speak as business men—about the last thing the companies desire at the hands of the Government, much as the public might desire it. But the simple fact is that to enter into active competition with the companies would be an act of cruelty which the press would be the first to condemn. We have all along consistently maintained that the Post Office ought to have stuck to its rights, and done the telephonic business itself; but having conceded what it has, we hold that it cannot in fairness pursue an injurious policy towards its licencees; and we confess to being rather glad to learn that

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public demand for its competition is apparently not "very pressing." On the other hand, we hold that the fact of granting licenses to private companies for the performance of State duties—for the Telegraph Act made electrical correspondence a concern of the State—the Government have incurred the responsibility for the acts of those companies. The *Edinburgh Courant* may call this official apology if it pleases; we call it common sense and common equity. If it is a fact—and the *Courant* appears to be far more conversant with official secrets than ourselves—that there was some difference of opinion between the permanent officials and the late Postmaster-General, and that some change of policy is contemplated now that he is gone—all that we have to say is that our apologies, like our criticisms, always have been, and always will be, for measures, not for men. The measure we are here discussing is one of public welfare; and we are not going to be silenced by ill-considered claptrap on the one hand, or inconsequential sermonising on the other. In the leading article immediately above the one in which we are censured for disapproving some of Mr. Fawcett's administrative acts the *Courant* itself makes a vigorous onslaught on Mr. Chamberlain and Sir Charles Dilke on account of their political utterances. Heads of Departments are apparently not more sacred in the eyes of the *Courant* than in ours. The difference is, that we stick to that business which we thoroughly understand.

As we said at starting, we had no idea that our suggestion would be taken so much to heart; but we are none the less certain that it must soon be adopted. And for this reason, if for no other, we have strongly advocated some immediate legislative interference with overhead wires. They will have to be bought some day; and then the country will not only have to pay for them but for putting others underground to take their places. The companies need not be in the least alarmed. Mr. Chamberlain is not yet in a position to demand a ransom for their privileges. What the country has permitted the country will pay for, unless it has grown suddenly and incurably dishonest. Overhead wires having reached the limits of toleration; their confiscation being out of the question; and it being evident that telephonic enterprise in the hands of private adventure will continue to be conducted on "strictly commercial" principles, which in this case mean cheap wires and dear messages, whilst under Government control the system would be worked for the benefit of the community, we are still of opinion that it ought to be compulsorily purchased—the sooner perhaps the better.

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is gratifying to find that my short note should have elicited two such valuable letters as those of Messrs. Sprague and Blakesley. With much of what they say I agree heartily. Mr. Walker's long diatribe re-states the substance of an equally diffuse oration, which at the Health Exhibition terminated vaguely and inaudibly amidst growing signs of disapprobation. Its tone is far less courteous than that of the two former correspondents; therefore, I shall only correct certain misrepresentations and pass on to the more pertinent strictures of the other gentlemen.

1. I do *not* hold "that the effects of lightning stroke are not the same as those produced by high-tension electric lighting currents."

2. My "own professional brethren" do *not* "bar the way when an opportunity occurs of turning a terrible lesson to advantage." The *post mortem* made at St. George's Hospital will, I hear, be duly published.

3. I have *not* administered a reproof to the Royal Society.

4. I *am* "aware of the case of a man having lived" sometime "after receiving an electric light current," and then dying from its effects.

On counting up the number of times the expression "may" or "may not" occurs in this letter, I find the total to be eleven. Now this phrase, under the guise of a question, puts forward entirely unsupported and hypothetical assertions. In most instances I should answer "No, it may not," but the real point is not whether it may, but whether it does. My one exception is with regard to the inhibitory action of the pneumogastric nerve on the heart. Here I am inclined to agree with Mr. Walker; but at present proof is scanty, and this he does not supply. When evidence is obtained, it will add a fourth to my three suggested modes of death, that namely by syncope.

Lastly, I sincerely hope it will not be necessary, in a matter so important, to arrive at Mr Walker's lame and impotent conclusion, that "the question of the resistance of the body *per se* is very much like the size of a piece of chalk." If this be true, my measurements are, indeed, as he tells me very politely, "so much time wasted." I will waste no more on him.

Turning with relief to Mr. Sprague's far abler letter, I may note that the figures in his first communication were 5,000 to 10,000 ohms, not 5,000 to 1,000, as given in his second, probably by a mere clerical error. That the "ordinary condition" is one of higher resistance than the instance named, I, of course, freely admit; but as I believe it to be "transitory, deceptive, and dangerous" (the words I wrote), the minimum is far the most important. Nor do I think my sulphuric acid illustration inapt, since it has actually happened to me. On another occasion the spark of a large Ruhmkorff coil distinctly leapt three or four inches across the back of my left hand, and "went in" at a little unhealed wound or abrasion rather than pass through the dry skin of the touching fingers. This also is a possible condition in a workman.

The real point of Mr. Sprague's letter is his sweeping condemnation of the measurement of resistance in electrolytes by means of alternate currents. This method is nowise new. It was employed by Wheatstone, and has been improved by Kohlrausch, whose own meter-bridge I am using. I have not heard its accuracy questioned before. But that the measurements thus obtained are considerably lower than those made with momentary alternated currents from an ordinary battery and bridge I not only do not deny, but have actually published such observations. Mr. Sprague has evidently not seen, or forgotten, papers contributed by me some time back to *Nature*, of which I have a reprint much at his service. My "gigantic clinical clerk" gave from foot to foot with the latter 930 ohms, with the former 650 ohms. I have been inclined to attribute the difference to the far higher E.M.F. of the induction coil, about 40 volts, over the 6 volts of three bichromate cells.

That something of a condenser effect may occur in a moist solid like the human body I am also quite prepared to admit; but it must clearly be a very leaky condenser. In this connection I do not quite understand Mr. Sprague's phrase "conducting capacity." Does he mean conductivity, or capacity, or a combination of both? He also rather begs another question by introducing the word "slight" before electrolytic action as taking place in the body. I believe it often is very far from slight, and, at any rate, shows itself in instant and marked polarisation. This Mr. Blakesley seems to state more accurately as follows: "The capacity will probably be found to be, like that of a voltametric series, variable with the charge." I have published a series of measurements in which this is explicitly stated, and I think in a measure proved. Hitherto I have been occupied with measuring the charging power of the currents used in physiology, which are extremely small, and do not appear to have been measured previously. All this also is in print.

My suggestion of thrombosis as a possible cause of death is not hypothetical, but derived from recorded symptoms, espe-

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cially in the Birmingham music hall case. The evidence will be far stronger if (as with Mr. Sennett's valuable aid I am anxious to do) we can obtain trustworthy *post mortem* records. Mr. Sprague's suggestion that a wire resistance balanced against the body may act as a short-circuiting shunt rather than as a fair derived circuit has considerable force, though he gives no proof of it; and if it be true it entirely invalidates what has hitherto been considered a safe method. Here he a little forces my hand, by obliging me to disclose an unfinished and what may possibly prove to be an unsuccessful device. I have built a meter bridge, in which the wire is replaced by a trough or tube a meter long, filled with some conducting fluid, such as sulphuric acid. The scale reading is given by a platinum disc or plate, freely movable from end to end. If no error has been overlooked, a thing of which I am not yet sure, one electrolyte will be balanced against a known quantity of another. It has also occurred to me that one man might be put in the bridge against another man, but this idea is still in embryo. It is not dissimilar to Mr. Blakesley's chain of men and dynamometers, which, with my willing and intelligent students, I really might be able to carry out. Your patient toleration of the wanderings and sinuosities of one correspondent's lucubrations is the only possible condonation of my own verbosity (I hope the phrase is parliamentary). Let me then say in conclusion that when a thing supposed to be new is started in science, especially in the electrical department, it seems to set up three counter-forces. First, it is affirmed that it is not new; secondly, that it is not true; thirdly, that it is of no practical importance. This subject is, I hope, passing safely through these three stages of evolution, and perhaps may be ultimately attended to.—Yours, &c., W. H. STONE.

DYNAMO-CONSTRUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With regard to the letter from G. C. Fricker in this week's *Electrician*, it is just what I wanted, and I daresay other students are glad to see it, for it is a question that one does not see treated in the books on electricity. Will Mr. Fricker or one of your other correspondents tell me what is meant by the term ampere turn? Also he assumes a certain E.M.F.; but supposing we are designing a self-exciting dynamo machine, how are we to know what E.M.F. will be generated by A at a given speed and with a given number of turns at a given velocity?

Could you, Mr. Editor, see your way to give the students who read your pages a few papers on designing dynamos, &c., and the laws which govern them?

I venture to say there are more students than myself who read *The Electrician* who have the skill and tools to construct first-class dynamos, &c., but who from lack of knowledge of the electrical portion fail miserably; and you will understand that it is a serious thing for people who have not much money to spend weeks and weeks, about 25s. to 30s. over a dynamo, and then find it does not work. Could you also tell me the price of Silvanus Thompson's "Dynamo Electric Machinery" and the publisher?—Yours, &c., THEO. PARDOE.

12, Cambridge-street, Newcastle-on-Tyne.

[We are arranging for some articles "On the Design and Construction of Dynamos."—Ed. *E.*]

HEATING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Sellon, I fear, takes the word "warning" I employed in a previous letter as applying to his inventions. Such was not my intention, and if my letter is carefully read, "warning" is given to those who might thoughtlessly start arrangements for heating by electricity.

Since writing that letter I find that my figures were far too good, and therefore the worse for electrical heating. It appears from Government experiments, made by Dr. Playfair and Mr. De la Beche, the recovered heat in the case of an ordinary steam engine (3lb. coal per indicated horse-power) is only 2·65 per cent. at the terminals of a good dynamo. The figures I gave were $0{\cdot}1 \times 0{\cdot}75$ of total $= 0{\cdot}075 = 7{\cdot}5$ per cent. recovered, which is three times too good. My desire at the time of writing was in no way to exaggerate the facts.—Yours, &c.,

DAVID SALOMONS.

Broomhill, Tunbridge Wells, 19th Jan., 1885.

SMALL MOTIVE POWER FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Replying to your correspondent "D," I have pleasure in giving some particulars of the small installation at my house.

The motor is one capable of giving out about two horse-power on the brake. The dynamo is one of Messrs. Paterson and Cooper's Phœnix machines. I am able to run sixteen to seventeen lamps of 20 candle-power.

My motor house is a little wooden shed, 9ft. long by 6ft. wide. It contains the motor and dynamo. Outside the motor house I have placed a hopper boiler connected to the motor. The hopper holds nine hours' supply of gas coke, and after the fire is lighted it requires no further attention. My man lights the fire, and starts the motor in the afternoon, and then leaves it, and I see no more of him for the rest of the day. The motor continues to work, maintaining a steady light all the evening. On going to bed I simply shut the damper, and leave the motor running; the fire burns low, and the motor stops. The next morning there is a little fire left in the hopper, and by opening the damper I am enabled to start the motor again should I require it. A continuous fire may be kept in the hopper if it is necessary. I burn about 120lb. of coke from four in the afternoon to nine the next morning—that is running the motor from five to eleven o'clock, and keeping in a little fire during the night.

In addition to the lamps, I have a heating coil in the house, which works from the motor.

The pipes to the coil are ¼in. lead gas pipes, carried into the house in the same manner as gas pipes are usually laid. In my case the pipes run up the walls and along the cornice, where they are out of sight. By this system of heating coils may be placed in any part of the house, and the heat conveyed to them by means of small lead pipes, so small that they may be laid almost anywhere without disfiguring the walls. It matters not how many twists and turns and ups and downs the pipes make.

With the motor it is also possible to supply the hot water cisterns of the houses with water at 120° to 140° of heat, either when the motor is at rest or during the time it is lighting the house.

The motor can be made to light and warm the house, and supply hot water to the bath and other hot water tanks.

The steam pressure employed is below the atmospheric pressure, so that neither the motor nor the heating coils are subject to any pressure whatever.—Yours, &c.,

HENRY DAVEY.

Rupert Lodge, Headingley, Leeds, 19th Jan., 1885.

INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will some of your readers who may be versed in the art and mystery of incandescent lamps kindly explain why, if a lamp be arbitrarily called a 20-candle lamp at any efficiency that it may suit the maker to fix, it follows, "*as a matter of course*," that if this lamp be run at 12 or 10 candles, which is much under its "*normal*" candle-power, its length of life *must be very considerable?* As the Commissioners of the Vienna Exhibition have said so, it is to be supposed that the statement has some foundation in fact, otherwise an ignoramus like myself would have supposed it was a joke.—Yours, &c.,

CARBON.

P.S. On reading the passage carefully, I observe the Commissioners have been careful to say "*should be*"—not "must be." Of what use is it to tell us what a lamp "should" do?

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THE INFLUENCE OF STRESS AND STRAIN ON THE PHYSICAL PROPERTIES OF MATTER.*

BY HERBERT TOMLINSON, B.A.

The effect of temporary longitudinal traction on the electrical resistance of cobalt was determined by a method similar to that already described in a former portion of this memoir,† and it was found that, like nickel, this metal has its resistance *decreased* by moderate temporary stress, in spite of the changes of dimensions which ensue. Whether the decrease of resistance would be changed to increase, as it is with nickel, by a greater amount of stress, has not yet been ascertained, but should this be the case, the magnitude of the stress per unit area which would suffice for the purpose must be much greater with cobalt than with nickel. As with nickel, permanent extension and rolling diminish the effect of temporary longitudinal traction, so that there is a larger decrease of resistance caused by a given stress with annealed than by unannealed cobalt.

Cobalt is remarkable for the extreme persistence with which the same load, when applied again and again, continues to produce permanent increase of resistance, and probably increase of length, but for a moderate amount of permanent extension the increase of resistance is more than accounted for by the permanent increase of length and diminution of section which take place; so that, as with iron and nickel, the *specific* resistance is *decreased* by moderate permanent extension. The permanent decrease of specific resistance per unit for unit permanent increase of length is, for iron, cobalt, and nickel, 0·02, 1·44, and 2·37 respectively; thus the permanent decrease of specific resistance, as well as the temporary decrease of resistance, is greater with nickel than with cobalt.

Since contrary to the expectation arising from the apparent relationship which exists between the "rotational coefficient" of Hall, and the alteration of specific resistance caused by mechanical stress,‡ cobalt behaved like nickel, and not like iron; the effect of longitudinal traction on the thermo-electric qualities of cobalt was examined, and it was found that temporary longitudinal traction renders cobalt temporarily *positive*, as regards its thermo-electric qualities, to cobalt not under traction, provided there is no magnetic stress acting at the same time on the metal. The results obtained would, therefore, not only be adverse to the above-mentioned hypothesis of the author, but also to Bidwell's theory that the "Hall effect" is due to the joint action of mechanical strain and certain "Peltier effects," were it not that in Hall's experiments the metal is under very considerable magnetic stress, which latter has been proved to alter very appreciably the thermo-electric properties of iron, nickel, and cobalt,§ and under these circumstances both the effect of mechanical stress on the specific resistance‖ and that on the thermo-electric qualities of cobalt may be different to what they are, when there is no magnetic stress acting on the metal.

Longitudinal magnetic stress was found to render cobalt negative thermo-electrical to cobalt not under stress.

The cobalt used was in the form of a strip, and the section, which was fairly uniform throughout the whole length, was 0·06168 square centimetre; the length was 58·4 centimetres, and the mass 29·65 grams.

The value of "Young's modulus" was determined by the method of longitudinal vibrations, the strip being held in the centre, and rubbed along its length with a resined glove.

The effect of longitudinal traction on the electrical resistance of unannealed piano steel was tried, the stress used being eventually increased nearly to the breaking point, with the view of ascertaining whether the increase of specific resistance which had been previously found to follow on moderate longitudinal traction might not be changed to decrease. This was not the case; but, on the contrary, whatever the permanent load might be, a temporary addition to this produced exactly the same temporary effect. The fresh experiments, however, confirmed the results obtained with the older ones, and agreed with these in making the alteration of resistance due to traction, both for unit stress per square unit of area and per unit increase of length, less for steel than for iron.

The electrical resistance of magnesium proved to be temporarily increased by temporary longitudinal traction of moderate amount, but the amount of increase was less than could be accounted for by mere change of dimensions, so that the *specific* resistance of magnesium, like that of aluminium, is *decreased* by the temporary stress. It was found also that *when the permanent load on the wire is very small*, both the temporary increase of length and the temporary increase of resistance due to traction increase in greater proportion than the load. The increase of length, however, increases less rapidly than the increase of resistance, so that when the stress exceeds a certain limit, the above-mentioned decrease of specific resistance is changed to increase. Probably a similar state of things would be found to occur with aluminium.

The value of "Young's modulus" was determined for magnesium, both by the method of static extension and that of longitudinal vibrations, the results obtained by the two methods agreeing fairly with each other. The "simple rigidity" was determined by the method of torsional vibrations.

The value of the "bulk-modulus" was determined from the values of "Young's modulus" and the "simple rigidity" to be $287{\cdot}6 \times 10^6$ grams per square centimetre, and this value agreed with that deduced from a formula given in a former portion of this memoir within 2 per cent. This formula is

$$e_v = 2071 \times 10^6 \times c_v J,$$

where e_v is the "bulk modulus" in grams per square centimetre, and c_v the mean thermal capacity per unit volume between 0°C. and 100°C.

The results obtained from the experiments on the effects of stress on the electrical specific resistance of magnesium are in perfect accordance with the view that there is a relation between the "Hall effect" and the alteration of specific resistance.

The electrical resistance of the alloy platinum-iridium* is *much more increased* by temporary longitudinal traction than that of either of the components of the alloy. On the contrary the electrical resistances of platinum-silver, German-silver, and brass are all *considerably less increased* than is the case with their components. This circumstance would rather militate against the employment of platinum-iridium in making standard resistance coils. The increase of resistance alluded to above is much greater than can be accounted for by change of dimensions, so that the increase of *specific* resistance produced by longitudinal traction is considerably greater than is the case with any of those other metals examined whose resistance is increased by traction.

The alteration of resistance above mentioned at first increases in greater proportion than the load, but, when a certain limit of stress has been reached, the ratio of the temporary increase of resistance to the load producing it begins to diminish, and finally reaches the same value as at first. A tendency to a similar state of things is seen with the other metals, but in none is the phenomenon so pronounced as in platinum-iridium.

The value of "Young's modulus" was determined for platinum-iridium, both by the method of static extension, and by that of longitudinal vibrations, and the results obtained were in fair agreement. "Young's modulus" is with the alloy considerably greater than with the two components, so much so as quite to equal if not to excel the value of the same modulus for piano-steel. The "simple rigidity" got by the method of torsional vibrations is also considerably greater with the alloy than with its components.

Unstretched platinum-silver was found to be thermo-electrically positive to the temporarily stretched metal, and forms a very striking exception to the rule which holds good for most metals, namely, that those metals which are *increased* to a comparatively large extent by traction in *specific* resistance are

* Being Part II. of a series. This paper treats especially of Electric Conductivity, and was read at a recent meeting of the Royal Society.

† *Phil. Trans.*, Part I., 1883, p. 58.

‡ *Loc cit.*, pp. 167, 168.

§ See Sir William Thomson's paper on "The Electrodynamic Qualities of Metals," *Phil. Trans.*, Part IV., 1856; also what follows.

‖ *Phil. Trans.*, Part I., 1883, p. 152.

* 90 parts by mass of platinum and 10 parts of iridium.

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TABLE I.

Name of Metal.	"Young's modulus" in grams per square cm. $=e$.	Load at the first "critical point" in grams per square cm. $=c_1$.	Load at the second "critical point." $=c_2$.	Load at the third "critical point." $=c_3$.	Load at the fourth "critical point." $=c_4$.	$\frac{e}{c_1}$ $\times 10^2$.	$\frac{e}{c_2}$ $\times 10^2$.	$\frac{e}{c_3}$ $\times 10^2$.	$\frac{e}{c_4}$ $\times 10^2$.
Nickel - - -	2175×10^6	$1{\cdot}158 \times 10^6$	$2{\cdot}200 \times 10^6$	$3{\cdot}100 \times 10^6$	—	18·79	9·89	7·02	—
Iron - - - -	1981	0·950	2·070	3·009	3825×10^6	20·86	9·57	6·38	5·17
Cobalt - - -	1817	0·896	1·687	—	—	20·28	10·77	—	—
Platinum - -	1490	—	1·400	1·520	2021	—	10·64	9·80	7·20
German-silver -	1291	0·637	1·274	2·197	—	20·20	10·14	5·88	—
Copper - - -	1174	0·607	1·165	1·886	2·625	19·35	10·08	6·23	4·35
Platiuum-silver	1051	—	1·081	1·741	—	—	9·72	6·04	—
Silver - - -	742	—	0·819	1·250	2·185	—	9·06	5·94	3·44
Aluminium -	673	—	0·730	1·120	1·293	—	9·22	6·01	5·19
Mean - -	—	—	—	—	—	19·90	9·90	6·69	5·10

TABLE II.

Metal.	Condition.	Density.	Young's modulus in grams per sq. cm.	"Simple rigidity" in grams per sq. cm.	Specific resist., *i.e.*, resist. in ohms of 1 c.c. between opposing faces for a temp. 16° C.	Alteration of resist. per unit for a long. traction of 1 gram. per sq. cm.*	Alteration of resist. per unit attending unit. inc. of length.	Alteration of spec. resist. per unit attending unit inc. of length.
Cobalt - - - - -	Unannealed	8·231	2005×10^6	...	2450×10^{-8}	$-242{\cdot}3 \times 10^{-2}$	—0·486	—1·986
Cobalt - - - - -	Annealed	8·259	1817	...	2289	—386·8	—0·703	—2·203
Magnesium - - -	Unannealed	1·743	430·8	$172{\cdot}3 \times 10^6$	565	+1841	+0·781	—0·719
Platinum and iridium	Unannealed	21·523	2089	724·8	2830	+3049	+6·368	+4·486

* A + sign in this and the next two columns signifies *increase* of resistance on the *application* of stress.

those which are rendered most thermo-electrically *negative* by traction.

A further examination was made of the "critical points" of metals, *i.e.*, points at which there is a sudden increase of the ratio of the permanent extension or permanent change of resistance produced by loading, and the load when the latter is increased by small and equal amounts at a time. This examination ended in the discovery of a *fourth* "critical point," occurring with a load exactly half of that at the previously so-called *first* "critical point;" further, it was ascertained that the four "critical points" are in the remarkably simple ratios 1 : 2 : 3 : 4. Table I gives the loads at the four "critical points," and their relation to "Young's modulus" for all the metals which have been as yet examined.

The above Table I shows not only that the four "critical points" are in the above-mentioned simple ratios, but also that with all metals the value of "Young's modulus" bears a constant ratio to the loads at each of the "critical points."

In Table II. are given most of those results of the present inquiry which can be expressed by numbers.

GARASSINO ACCUMULATOR.—In the new arrangement of accumulator devised by Signor Giovanni Garassino, cylindrical glass cells, like those used for an ordinary battery, contain discs, alternately of lead and ebonite, immersed in acidulated water and connected by metal wires. These accumulators are ready, almost immediately after being charged, to give out electrical energy; and the great thickness and area of the discs permits of retaining the charge for several days without much loss of energy.

THE CINCINNATI ELECTRICAL SOCIETY.

The first year of this society's existence was completed on Dec. 20 last, when the 29th meeting was held, and the first annual report presented. A few persons desiring to study the subject of electricity met every Saturday evening; and, after these meetings had been continued for some time, the Ohio Mechanics' Institute, about the oldest institution in the city, proposed they should join the institute and form an electrical section. The proposition was accepted, and the society met at the institute for the first time on Saturday evening, 23rd February, 1884, and have met there ever since at the regular time with but one exception. The present number of members is eighteen, and the number of new members added during the year is seven. The discussions were voluntary. Members so disposed prepared themselves, and made their own apparatus and experiments. The subjects for discussion were generally taken out of standard electrical books, and treated in the order and manner found therein. The following apparatus and experiments have been made by different members of the society:—A set of instruments illustrating the subject of electro-dynamics, being a multiplier and movable wires for angular, parallel, and sinuous currents; apparatus to show the rotation of vertical by horizontal currents; rotation of currents by magnets, rotation of liquids, solenoids; a Camacho electric magnet, made in sections; an electro-motor, without core to armature; an astatic galvanometer; a thermo and secondary battery; the Wheatstone sliding bridge apparatus; a reflecting mirror galvanometer. With these instruments the principles and experiments for which they were designed were successfully shown, besides quite a number of other original experiments.

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EVOLUTION OF THE ELECTRIC RAILWAY: Its Commercial and Scientific Aspect.*

BY DR. W. ADAMS, MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

(CONTINUED FROM PAGE 211.)

Let us for a moment look into the construction of this anomaly. It is composed of two parts, one constituting the "field" of the motor, and at the same time serving as the tyre-supporting portion of the wheel; while the second part represents the "armature" of the motor, and revolves within, and in an opposite direction to, the first. Hence it will be observed that the wheel is formed of two separate and distinct parts, both of which revolve, but in opposite directions. Both parts have a continuous tendency to pull towards each other, the poles of the two electro-magnetic rings, or inductors, being always kept at a minimum distance apart. The two electro-magnetic rings mutually act upon each other inductively throughout their entire length. The inner ring corresponds to the armature of a dynamo machine, and revolves as 3 to 1 of the outer ring, which latter in turn corresponds to the field of a dynamo (Fig. 3). Their relative speeds are maintained through the agency of an epicycloidal train of either friction or toothed gearing, the internal gear being carried by the outer ring or field, while the central, or "sun-wheel," is mounted upon the hub of the armature with an intermediate friction clutch. The intermediate or floating wheel is carried by a frame, forming one with, or rigidly attached to, the car axle-boxes. Thus do all geared parts move together always in line. The armature is mounted upon a hub in the form of a sleeve, which revolves upon the car axle.†

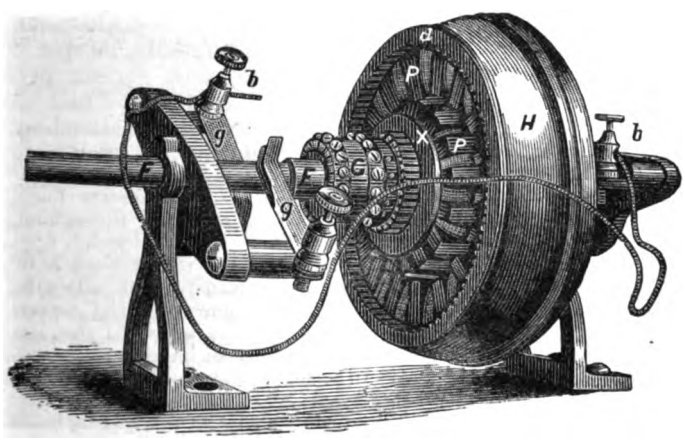

FIG. 3.

Here we have the weight of the machine directly at the point of traction—the tractive power is distributed to every wheel and thus applied directly to the point of traction. The armature may revolve independently of the wheel—hence it may be allowed to attain a high velocity before applying the load, which can be applied slowly and advantage be taken of the impetus of the armature to overcome the inertia of the car on starting. Thus, also, are we not obliged to jeodardise the life of the armature. Again, we are by this arrangement afforded a purely mechanical means of controlling the speed of our car without introducing useless resistance, since by allowing a slip at the friction clutch the armature will run at a proportionately higher speed and generate a higher counter E.M.F., which acts as a resistance and allows less current to pass through the machine, while at the same time the machine is working more efficiently, since its E.M.F. is approaching nearer the E.M.F. of the generator or line. In moving the field as well as the armature, we produce an effect equivalent to increasing by one-third the number of sections in the armature beyond what is mechanically practical, and thus do we raise the electro-dynamic efficiency of the motor. The construction of the motor also is such as to greatly increase the leverage through which the work is done, the pull between the armature and the field being at a considerable distance from the centre. Again, the electro-magnetic construction is such that the armature and the field are subjected to each other's inductive influence throughout their entire length.

This animated wheel is particularly well adapted to one-rail elevated roads, and there is no telling what speed might be attained with wheels like this of from 4 to 6 feet in diameter. In another form I have taken the field from the wheel and made it stationary around the axle between the wheels, the armature revolving as before on the axle, the whole forming an electric truck (see Fig. 4), which is in no way attached to the car, and which may therefore be removed from under or placed beneath a car at pleasure in a few minutes. Here, also, all parts are in line and move together, since the field is rigidiy attached to and forms one with the car-axle box. The power is here transmitted through an epicycloidal train of friction gearing at each end of the armature.

We come now to a detailed consideration of the question of percentage of return. The return of a "dynamo" machine with regard to another which puts the first in motion is expressed by the proportion of the useful mechanical work developed by the second to the work absorbed by the first. This may be estimated in two different ways: first, by appling a dynamometer to the generating machine and a Prony brake to the motor; second, by measuring the intensity or quantity of the current traversing the two machines. In the latter case, the mechanical work absorbed by the first machine and that returned by the second may be ascertained by the electric measurements taken, if we but apply certain fundamental dynamic theorems. Of necessity, such a return would be somewhat higher than that obtained by direct mechanical measurements, since it is simply that which we should obtain in practice if the two machines were perfect—that is, free from friction and certain electric imperfections. Unlike the steam engine, however, which returns us but 10 per cent. of our energy in the form of available work, we get in the electric engine a return of 90 per cent., the above-mentioned sources of loss consuming but 4 or 5 per cent. By Joule's law we can easily calculate the mechanical work developed in the form of heat in an *inert* circuit. This is expressed by one of these three formulæ, RI^2, $\frac{E^2}{R}$ or EI.

The first supposes the resistance (R) of the circuit and the quantity (I) to be known; the second supposes the electromotive force or pressure (E) and the resistance (R) to be known; and the third supposes the electromotive force (E) and the quantity (I) to be known. The last two may be deducted from the first, observing Ohm's law $I = \frac{E}{R}$.

Suppose now that instead of the circuit being *inert* it contained

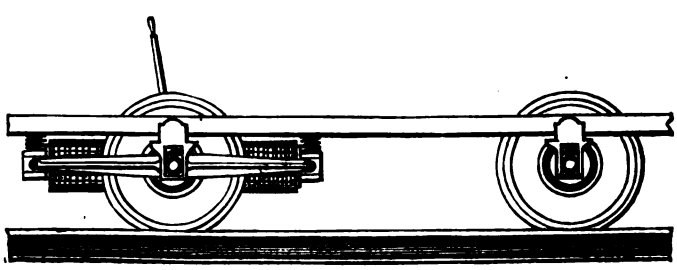

FIG. 4.

a perfect electric motor (the Pacinotti type) free from friction, &c., and provided with a brake.

The total energy developed by the source of electricity now appears in the whole circuit in two different forms: heat and work. The quantity of the current being the same throughout the circuit, the heat developed in the whole circuit is expressed by $\frac{RI^2}{g}$.

The total quantity of the work generated and expended in the circuit is expressed in kilogrammetres per second by $\frac{EI}{g}$.

Supposing, now, T to be the mechanical work produced by the motor expressed in kilogrammetres per second. Then, since the total energies developed by the source equal the sum of the partial energies developed in the whole circuit, we have the equation $\frac{EI}{g} = \frac{RI^2}{g} + T$; whence it follows that we have $T = \frac{I(E-RI)}{g}$ where $E - RI$ represents a negative E.M.F. (e). Hence we conclude that where a motor performs work it necessarily generates a counter E.M.F., and this experiment proves true.

We are now, therefore, brought to the equation $T = \frac{eI}{g}$, or remembering that $I = \frac{E-e}{R}$ $T = \frac{e(E-e)}{gR}$, so that the total energy developed by the source becomes $T = \frac{EI}{g} = \frac{E(E-e)}{gR}$, and the work lost in the form of heat $\frac{RI}{g}$ or $\frac{R}{g}\left(\frac{E-e}{R}\right)^2$ or $\frac{(E-e)^2}{gR}$.

These expressions constitute the fundamental equations of the theory of the electrical transmission of power. Dynamometric measurements have of late proved that the expression $\frac{EI}{g}$ represents about ·95 of the mechanical work applied to the pulley of the generator after deductions are made for the work expended in

* Paper read before the Society of Civil Engineers, America.

† The lecturer here showed several models in operation.

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overcoming friction—that is to say, if the total work applied to the generator is represented by 100, and the work absorbed by friction by 10, the product $\frac{E I}{g}$ may reach 95-100th of the remaining work (100 – 10) absorbed in purely electric work, or 85·5 per cent. The difference, 90 – 85·5, then represents the loss due to electric inperfections, which I have already said amounted to 4 or 5 per cent.

These fundamental equations enable us to calculate the value of the economic return. For if we call k this return, then $k = \frac{e I}{g} \div \frac{E I}{g} = \frac{e}{E}$.

You notice, then, that this expression is *independent* of the *resistance* (R), so that we may conclude that the economic return depends only upon the proportion between the counter electromotive force of the motor and the positive electromotive force of the generater. This is what M. Deprez tersely expressed when he said, "The return is independent of the distance." The *absolute work*, however, is not independent of the distance. If we would maintain constant the work transmitted, whatever the resistance or distance, M. Deprez has shown that the electromotive force of the source must be increased proportionately to the square root of the resistance. It is a misunderstanding of this point which has led some superficial critics to dispute the results of M. Deprez's work. No rational person would advocate the possibility of transmitting the power of Niagara over a telegraph wire for an unlimited distance. Neither can I conceive of an instance where one would think of putting in a plant to transmit 10 horse-power over a telegraph wire to a point distant 25 miles from the source. Surely, no one would think of establishing a plant for the hydraulic or pneumatic transmission of 10 horse-power to a point distant 25 miles. Why, then, should such absurdities be expected of electricity? In order to see the influence of resistance in the circuit on the absolute work, we must introduce into these equations the value of the return k, which it is *desired* to obtain. From the equation $k = \frac{e}{E}$ we have $e = k\,E$, and making use of this value e in the preceding equations, they become:—

Work absorbed in generator, $\frac{E^2(1-k)}{g\,R}$,

Work recovered in motor, $\frac{E^2 k(1-k)}{g\,R}$,

Work lost in the form of heat, $\frac{E^2(1-k)^2}{g\,R}$.

Thus, the absolute work of the receiver may be the same in two different experiments, although the economic return has very dissimilar values. These differences result from the weight put on the brake. According as the weight on the brake is great or small, so the speed of the receiver is low or high, but the work per second may be the same. This work also may be *nil* in two cases—when $k = 0$, and when $k = 1$.

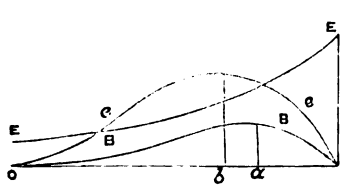

FIG. 5. Knapp's Diagram for Power and Efficiency.

Speeds are plotted as abscissæ, and the electrical work absorbed in watts divided by 746 as ordinates. Then with series wound motors we obtain curve E E, the shape of curve depending on type of motor. Variation of speed obtained by loading brake with different weights. Maximum speed O M. There is a speed at which the external work is a maximum. After loading the brake with varying weights, plot resulting speeds and horse-power as abscissæ and ordinates, which produces the curve B B. $e = \frac{B}{E}$ made with arbitrary scale gives commercial efficiency. Speed for maximum external horse-power is $o\,a$. Speed for highest efficiency is $o\,b$.

This diagram (Fig. 5) very beautifully illustrates geometrically the relationship which exists between the work done and the efficiency, as also the relationship between e and E.

We see from this that there is a value for the economic return, for which the useful work of the motor is the greatest possible. The sum of the two expressions k and $1-k$ being constant, this maximum is reached when they are equal—that is to say, when $k = \frac{1}{2}$. This further gives the result $\frac{E^2}{g\,R}(1-2k)$ of the second term of the second equation. The useful work received therefore becomes $\frac{E^2}{4\,g\,R}$, and the work spent in the generator $\frac{E^2}{2\,g\,R}$. If the receiver were prevented from turning we should have $k = 0$, and the work absorbed by the generator then becomes the greatest possible, or $\frac{E^2}{g\,R}$, the identical value we found for an inert circuit. From this we see that the maximum mechanical work developed by the receiver corresponds to the economical return, being equal to one-half, and that when the economic return is varied between 1 and zero the work spent in the generator constantly increases from zero to $\frac{E^2}{g\,R}$, although the electromotive force remains constant.

It is from not having well comprehended these simple considerations that many have lately written a vast amount of inaccurate criticism on the electrical transport of force. For example, one of the most common of errors is the belief that the economic return can never exceed 50 per cent., because it reaches this value when the work developed by the motor or receiver is the greatest possible in value. We have analogous conditions in thermodynamics, why not apply such reasoning in their case? Take a case in point now of two precisely similar machines, one acting as a generator, the other as motor. Remembering that the current is equal throughout the circuit, and that a constant current produces a uniformly constant field, and that the E.M.F. of a particular generator depends upon its speed and the strength of its field, then it follows that calling the corresponding electromotive forces and speeds of the two machines e, E and v, V respectively, and k the return, we shall have $\frac{e}{E} = \frac{v}{V} = k$. We thus come back to the value $\frac{e}{E}$, which we have already obtained for the economic return by quite a different method.

Regarding the recent experiment of M. Deprez, when it is remembered that before this experiment the boldest enterprise in this direction was a 4 millimetre *copper* wire, 6,400 metres long, with a resistance of only 8·4 ohms, carefully insulated throughout its entire length, and that M. Deprez chose an iron telegraph wire exposed to the rain, 114,000 metres in length, with a resistance of 950 ohms, and that notwithstanding these enormous differences in the conditions of the two experiments, the same industrial return was obtained, namely, 50 per cent., it will be conceded that the Miesbach-Munich experiment was of the utmost importance in the history of the transport of force. In this experiment, notwithstanding the high electromotive force employed (1,400 volts) and the poor insulation of the line, not one per cent. of the current was lost by leakage. It is extremely unfortunate for the engineering profession and the people at large that M. Deprez has been so misunderstood, for it has resulted in the creation of some very erroneous impressions in the minds of some engineers concerning the electrical transmission of power. Let me cite an instance in point: Perhaps some of you have noticed a paragraph going the rounds of your journals to this effect:—"M. Deprez has succeeded in transmitting a current of electricity equivalent to five horse-power along a telegraph wire one-sixth of an inch in diameter, some ten miles long, with an expenditure of 29 per cent. of the power." Compared with wire rope, this means falls short in actual *efficiency* (mark you, *efficiency*), since Messrs Hems send 500 horse-power along a ¾in. rope. Such logic is ridiculous, and should not find place in scientific journals. Pray tell us, in the first place, what has the *efficiency* to do with the respective sizes of the conductors in the two systems; and, second, one might as well impose upon the teledynamic advocates that they transmit their 500 horse-power by means of a ¾in. twine, as to impose upon the advocates of electrical transmission the necessity of using an iron wire one-sixth of an inch in diameter for the transmission of the same power. As a matter of fact we can transmit electrically 1,340 horse-power over a copper conductor of but half an inch in diameter, a distance of five miles, with a loss of but 10 per cent in the line. Aside from the difficulties attending its subdivision and application, the transmission of such an amount of power by a wire rope of like size and over a corresponding distance would be impossible.

(TO BE CONTINUED.)

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 16th January amounted to £4,026.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th January are £2,763, as compared with £2,571 in the corresponding period of 1884.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 16th January were £2,914, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Company.

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LEGAL.

Judgment Invalidating Debentures.

EDWARDS V. THE DUPLEX ELECTRIC LIGHT COMPANY.

The further hearing of this case was continued in the Chancery Division (before Vice-Chancellor Bacon), on Friday, Jan. 16.

Mr. MILLAR, Q.C., resumed his argument, and reminded his Lordship that his points were two—1st, that there was no quorum at the meeting at which the resolution was passed sanctioning the issue of the debentures; and, 2ndly, that the debenture deed was not in accordence with the Bill of Sale Act of 1882. At the meeting of the 3rd of May, 1883, Hunt was the only director present. C. Drake was not present at all, and Ilidge did not come in till after the meeting was disposed of. Going through the minute book of the Company, the learned counsel pointed out that there was a committee meeting in May, at which it was resolved that the debenture prospectus be issued, but no fixed scale to be adopted, and that tenders should be received. On May 18 Mr. Ilidge and Mr. Drake were the only two directors present, and at that meeting the mortgage to secure the debentures, which was authorised by the Board on May 8, was approved. What passed at a meeting on May 22nd showed that there were only seven sets of debentures allotted. Several letters of protest from some of the shareholders were read. On May 29th there was a committee meeting, and again only two directors present—Ilidge and Hunt. On that day it was decided with reference to Woodhouse and Rawson's account to offer them debentures as security for the lamps they had supplied, to be returned on payment of the amount, and that portions of the cable should be returned. This offer of a royalty of 3d. a lamp for the right of manufacture was not accepted. He (Mr. Millar) merely quoted the case of Woodhouse and Rawson in order to show one transaction among several in which debentures were only issued as collateral security, to be handed back to the company after having answered a temporary convenience. The liquidator, by whom he was instructed, represented the creditors of the company, and not the debenture holders. Someone must go unpaid, and if the debenture holders were paid the creditors would have to lose their money altogether.

Mr. MARTEN, Q.C.: The trust deed is signed by two directors, Ilidge and Drake, and the debentures by Lily and Ilidge, so that was having three directors agreeing.

Mr. MILLAR, Q.C.: Then my learned friend's argument is this, accepting for the moment the resolution of the directors not to be binding on the company, it has, nevertheless, approved the issue of the debentures, because the bill of sale is signed by two directors; and some debentures which were issued at a different date were signed by one other director, and that, he says, gives the same authority to the transaction as if the three had met together at the Board meeting. But it is quite clear the proceedings cannot be regular if you met one director at the office, one in the court corridors, and another at dinner in the evening, and got each to sign the document. His (Mr. Millar's) proposition was that a quorum of the Board meant a meeting as a Board. Counsel then proceeded to quote the case of Darcy *v.* the Tamar Railway Company. (Law Reports, 2 Exchequer, p. 158.) In this case the secretary had affixed the seal of the Board to a deed, having obtained the signatures of two of the directors at two separate private interviews, the quorum of the company consisting of three. Baron Martin, in delivering judgment in the case, said "that it was not necessary that there should be a fixed place of meeting, but it was quite clear that the directors should act together. Authority had not, therefore, been given as to enable the secretary to affix the seal." Baron Bramwell concurred, adding "that if such a thing was allowable a quorum of the directors might meet at one place and come to one decision, while another with equal authority meet in another place and come to another decision on the same matter." With regard to the second question, viz., whether the deed of trust was valid under the Bill of Sale Act? In the first place there was no schedule of plant annexed as required by the Act, yet singularly enough there was a schedule of the patents, which had turned out not to be extremely valuable. The next objection to the deed was that it did not truly state the consideration. He might mention that the deed, which was dated the 17th May, 1883, had been registered under the Act, though of course that fact alone did not bind them. In the case of Brocklehurst *v.* Eldridge, reported in the *Weekly Notes* of May 15, 1884, which was a case almost exactly similar to the present one, Mr. Justice Field had decided that the deed in question came under the Act of 1882, and required an inventory to be annexed. Also in the case of the National Fund Company the same decision had been come to. He would also bring before the learned Judge the case of Davis *v.* Burton, 11 Q. B. W., p. 537, which came before his Lordship himself, when he said "that this Act of Parliament should be considered with the utmost regard, because it was intended to protect creditors." As to the consideration, it was stated to be as follows:—"That the directors had determined to borrow £20,000 for the purposes of the company." But if this was a truthful statement the deed was not in accordance with Section 8. As a matter of fact, the directors never had to borrow £20,000, and never determined to borrow any such sum. As was shown by the circulars to the shareholders of May 12, 1883, and June 4, 1883, the last being issued within two days of the winding up, when the company were "in extremis." On the first one the shareholders were invited to take up the debentures, and an explanation was given as follows:—Suppose you are a holder of five shares, for which you have paid five pounds each, by expending five pounds further for the purchase of a debenture you will hold a first mortgage security, and be paid in about five years hence, and if the company shall continue very successful you will still have your share in the profits; and the circular of June 4 made it even more clear than the first one. He (the learned counsel) contended that the Board never determined to raise £20,000, but £10,000. And what was the final result? 306 debentures were issued in all, and of these 133 were issued at the rate of £5 each, which amounted to £665. Of the 133, seventy-two were issued after the commencement of the winding-up, and every one knew what would become of them. Some of the 306 were not issued as debentures at all, but as security, which was shown by correspondence with the firm of Woodhouse and Rawson. There was a letter from Dr. Emmens to that firm dated the 3rd July, 1883, enclosing twenty-five debentures to be held against their claim for lamps, to which Messrs. Woodhouse and Rawson replied as follows: "We have to acknowledge the receipt of twenty-five debentures to be held as collateral security against our claim for lamps sold to you and stocked with us." There was therefore this issue to creditors for which the company did not get a shilling. His contentions were therefore these. 1st. There was no deed because the seal of the company was not to attached. 2. Under the Bill of Sale Act 1882 it was void.

The learned counsel concluded by apologising to the Court for having occupied so long a time.

Mr. Edward John Cunningham was then called and examined by Mr. MILLAR, Q.C. He said that he had been in the employ of the Duplex Company previous to the winding-up from September, 1882, to July, 1883, as assistant-secretary. He was acquainted with the books of the company. Dr. Emmens was not a director. In the attendance book W. G. F. Hunt, Chas. Drake, W. Lily, and E. B. Ilidge were put down as being present on the 8th of May, 1883. Only Mr. Hunt was present at the time of that meeting. Mr. Drake was not present at all. Mr. Ilidge came later in the day, after the meeting. No notice was sent to any of the directors of the meeting of the 8th of May. No register of debentures was kept; 386 debentures were issued—133 to shareholders at £5 each; 61 were issued before the 6th June and 71 after. The balance of the 386 was issued to creditors. Some were issued before the winding-up and some after. Only 12 were issued for the consideration of £10 each before the 6th June.

Cross-examined by Mr. MARTEN, Q.C.: Witness was not present at the Board meeting. He was in a room that the directors would pass through. Was not in the office the whole day. There was a private way to the office. Mr. Ilidge could have come in that way possibly. He knew Mr. Ilidge came afterwards, because he was in the secretary's office sometime in the evening and saw him come in.

By Mr. LEVITT: The meeting of the 22nd was held in Mr. Emmens' room. He saw Mr. Ilidge come in; he passed through his room; also Mr. Rushton, the company's solicitor, but did not see him leave. Did not leave the office till late that day—not till half past five. Knew the meeting was over when he left, because he was in Mr. Emmens's room before he left. Could not say what time the meeting was commenced, but presume it was two o'clock, as that was the usual time.

Mr. BEAUMONT said he wished to call Mr. Rushton, formerly the solicitor to the company, but as he was not present, with his lordship's permission, he would call him later on. The learned counsel then briefly addressed the Court on the second point of the defence, adding to the authorities quoted by his learned leader (Mr. Millar) the cases of Davis *v.* Goodman, Hamilton *v.* Chain, 7 volume, 2 B. W., page 719, and that of the Charing cross Advance and Deposit Bank.

Mr. F. S. Rushton was then callen, and examined by Mr. BEAUMONT. He stated that he was solicitor to the company in May, 1883, and prior to that date, and obtained counsel's opinion in reference to the trust deed they were then proposing to execute. The first opinion was obtained on the 7th May, 1883, and the second on the 10th May, 1883. He was present at the meeting on the 8th of May, and arrived at four o'clock. There were several persons present, Hunt, Ilidge, and Dr. Emmens among them. Could not say whether Mr. Drake was present, as he did not know him then. All the questions put to him were put by Mr. Hunt. All the gentlemen present talked with one another.

Cross-examined by Mr. MARTEN, Q.C.: He left a little after six o'clock by the side entrance, by which he would have had no occasion to pass through any other room. The opinion referred to had reference to the powers of the Directors to treat the working expenses of the Company for the first two years as capital, and so to allow them to regard as profit all that was earned by the Company, without regard to the expenses incurred in earning the profit. He had to lay a similar case before another counsel. It was with reference to the issue of debentures and the payment of an interim dividend. The second opinion was practically a corroboration of the first. The point upon which counsel gave opinion was particularly in respect to the question whether the Company could accept the fully paid-up shares as payment for the debentures or as security. There was a question as to, in the event of the Company not being able to take payment for debentures in shares, what discount would it be reasonable to allow to persons to take up debentures at £10 each, and whether the Company could hold out an inducement by saying that they would be returned within a certain time with bonuses.

The further hearing of the case was adjourned till Monday, when

Mr. MARTEN, Q.C., in replying for the plaintiff, said that as to his first point with regard to the validity of the issue of debentures, his lordship would remember that he cited some cases in his opening as to the estopel of the company from disputing the issue so far as regards the power of the directors to make the issue, which Mr. Millar did not in any way touch upon. The Articles of Association set out that the directors might from time to time appoint a general manager, who should have power to act with the power of the Board excepting at Board meetings, &c. In the present case Dr. Emmens had been appointed under that article. The Articles of Association also provided that from time to time the directors could issue debentures, bills of sale, mortgages, &c., provided they were

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signed by two directors, and countersigned by the secretary or other officer appointed by the Board, and that the seal of the company should be affixed. Here the debentures had been signed by two directors and the general manager of the company. His lordship would remember that he (the learned counsel) in his opening had cited the case of the Romford Canal Company (24 Chancery Division, page 35), which set out that where a Board of Directors have issued debentures, an illegality in the issue cannot be set up against the holder if he has a right to assume "*omnia recta alia*," and in that case the debentures were held to be legal. He therefore submitted upon that, as regards any irregularities in the issue of the debentures, the case was completely precluded by the fact that there was power to issue them in the way they had been issued. Then, the liquidator said the debentures were approved only conditionally, and that three directors were not present. His Lordship had seen the agenda book, which contain the entry of the persons present, and in it the names of three directors had been written. The fact of their being entered in different handwriting did not in the least degree detract from the validity of it, and the other side had not called any one who was present to give evidence as to their absence except Mr. Rushton (the company's solicitor); and he said Mr. Hunt was present, and put the questions to him. Mr. Ilidge, who, it was said, did not come in till after the meeting, was also present, together with Dr. Emmens. The witness then went on to say that there were other persons present at the meeting, but Hunt and Ilidge were the only two he then knew. The other witness, Mr. Cunningham, was a clerk occupying an office in another part of the building, and could not speak of his own knowledge who was present and who not. The fact of his not seeing Mr. Drake go in could be explained by his going in at the private entrance, and the meeting of the company having taken place at half-past three instead of two o'clock. Mr. Cunningham said he did not recollect anyone leaving, and that showed they must have all left by the private way. Moreover, Mr. Rushton said he left by the private way. Looking at Mr. Rushton's evidence, it shows that he knew nothing about this particular meeting at all. In Section 67 of the Companies Act it says: "Until the contrary is proved, every general meeting the company shall have shall be deemed to be duly convened and all acts done shall be valid." Then it goes on to say: "Any minutes of the proceedings shall be received as evidence in all legal proceedings if signed by the chairman and made at the time." Now the minute book of the company is perfectly good evidence against the company, and Mr. Rushton's evidence, so far as it goes, entirely confirms the minute, because he says Mr. Ilidge was present, while Mr. Cunningham's evidence was entirely based upon the supposition that the meeting was held at two o'clock, when it turns out that it was not appointed till three o'clock. Then it was said, admitting that there was a quorum present, the resolution was only "conditional" subject to counsel's opinion. He (the learned counsel) asked Mr. Rushton about that, and he said the counsel's opinion related to some further question, and the result was that the proposal was broadly approved. Then there was a Board meeting, at which Messrs. Hunt, Ilidge, Drake, and Emmens were present, and a series of debentures were then allotted; so he submitted that any question as to informality was out of the question, because they had the meeting at which the debentures were approved. The directors must be assumed to have considered whether the debentures were properly sanctioned by the Board of Directors, and he (Mr. Marten) contended that the question as to the considerution of the debentures completely gave validity to the terms and provisions of the transaction, and that the issue of the debentures was not a mere ministerial act, but one for which each director would be personally liable if they were not properly issued. The defence contended that if three directors were not present the deed must necessarily be invalid, and a case was cited—viz., Darcy *v.* the Tamar Railway Company. That was a case in which the railway company were held not liable upon a deed which had not been executed within the requirements of the Act, but it is totally different to the present case, because all that is required here is the signature of two directors and the secretary. That particular case came under his Lordship's notice in the case of the Bonelly's Telegraph Company, 12th Vol. Equity Cases, p. 246. In that case it was held that the agreement was not *ultra vires*. There was a letter written and signed by two directors, and then handed to a Mr. Collig, who was the claimant, who returned it to the directors after having signed it. He (the learned Judge) said "he quite agreed that 'combined wisdom' was required in that case, he meant that they should all be of one mind, but it was not necessary for them to be all in one place. He could conceive many cases in which the presence of three directors could not be procured. It was not necessary, in his opinion, that what was done by directors should be done in one place." His Lordship went on to say, "the case of Darcy *v.* Tamar Railway Company was referred to by the other side, I may say, somewhat triumphantly. In his opinion the rules were made for the protection of the directors alone." Another case referred to was Cooke *v.* Warne, 2, Common Pleas Division, 305, which says, "Where a Board is constituted by Act of Parliament power must be exercised by them in the concern, and one of them acting alone cannot justify his acts by Act of Parliament," but that was entirely outside the present case. The company could not raise the question and plead the question *non est factum*, because the seal was duly affixed according to the Articles of Association. With regard to the second point, as to the deed not being in accordance with the Bill of Sale Act of 1882, in the first place it did not touch the validity of the deed so far as the patents and uncalled capital was concerned at all. The case which was greatly relied upon on the other side was that of Brocklehurst *v.* the Railway Publishing Company. In that case the execution creditor's rights were in question. In Section 4 of the Bill of Sale Act of 1882 there was an express saving of his rights as against the grantor, and the section said that every Bill of Sale should have an inventory of the chattels and the goods, &c., contained therein annexed. The argument before Mr. Justice Field turned upon the position of matters as regards the execution creditor and the grantor himself. Now Section 17 of the Act said:—"This shall not apply to any incorporate company or affect any mortgage, loan, and security upon the stock and goods of any such company." So he (Mr. Marten) contended that it was quite clear the Act did not apply to incorporated companies. The object was to protect floating securities of this kind, which were very common indeed with regard to companies; but according to Mr. Justice Field's view you could not have any such security, as it destroyed at one blow all debentures. It was said the decision applied to trust deeds, and did not affect securities; but securities relied on the trust deed. It was impossible to register a deed of this description in accordance with the Act, as the security was to be a floating one, and include the subsequent goods as well. The learned counsel then commented on the case of Gardiner *v.* the London, Chatham, and Dover Railway, and went on to say that the Marine Mansions case and that of the Asphalte Company had not been referred to on the other side. It was clear that under the former Act of 1878 these debentures were not held to be within the Act; why then should a different construction be given to the Act of 1882? As to the consideration not being truly stated, he contended that the consideration was truly set forth in the present case, as it said the object of the company was to raise money for the purposes of the company. The learned counsel concluded his address by reading the inquiries, &c., he wished the Court to order, should judgment be for the plaintiff.

Vice-Chancellor BACON, in delivering judgment, said that on the third day of the hearing of this action he was now about to give judgment on the first point at issue. The object of the Legislature was to protect shareholders, and limit and define the powers of the directors, and if those objects were not kept steadily in view in all the transactions of a joint-stock company the transactions were void. What he had to deal with in the case before the Court was whether the directors might borrow sums of money as they thought fit. As he (the learned Judge) understood it, the company having exhausted all its means, the directors, acting under the advice of a gentleman called "Doctor" Emmens, he being present at the Board meeting, for it says in the minutes of what took place at the meeting, there were present Hunt, "the Doctor," Drake, and Ilidge, three directors being required to make a quorum, and he found the following entry: "The consideration of the general manager's suggestion to issue first mortgage debentures." He found no record of any resolution which was come to, but the words were "approved, subject to counsel's opinion," and the minute was neither signed by any director then present nor by any other person. Neither was there any authenticity to the minutes of of May 10, which were signed by Mr. Ilidge. Now, the 67th section of the Companies Act provided that every company should provide minutes of the proceedings of their meeting, duly entered in the books of the company and duly signed, &c. He (the learned Judge) did not find any signatures to that minute, and his opinion was that that minute was illegal. If the company had had entered in the minutes of the next meeting that the minutes of the last meeting were read and confirmed, and that signed by the directors or chairman, possibly that might have given rise to argument; but there was no such resolution, and that made all that they have done "illegal" and "invalid." There was a question as to three directors being present, and upon that question no evidence was clear. There was none on the part of the plaintiff, who might have invited the attendance of Mr. Ilidge or some other person present to prove it. That of the defendants is that Mr. Ilidge did not make his appearance until afterwards. There were two instances, and he was asked to infer that Mr. Ilidge might have crept in through the "Doctor's" entrance; but he would not adopt such opinions, he wanted evidence. If he looked at the book for any purpose he should find all that was entered was that there was an approval of the Doctor's suggestions, provided that counsel should approve of it. And the evidence was that two counsel advised the directors that what was proposed was illegal and could not be carried into effect. The opinions were not produced, and he (the Vice-Chancellor) did not think it necessary that they should be, but the plaintiff was bound to produce some evidence on the subject, and they had got none. Then he was referred to two circulars from the manager to the shareholders, in which he says that the scheme "had been adopted with a view to enabling the shareholders to realise their shares without being affected by the condition of the share market," and explained that if they held shares on which £5 had been paid up, by paying another £5 on each of them they could get a £10 quotation, or in other words a first mortgage on the property of the company, and have the full amount paid off in five years at the most, and that should the company continue to be a success they would still participate in it. That meant this—those of you who are already shareholders in this company, and have contributed £5, which is your money no longer, but the money of the company, if you will give us £5 more we will give you a mortgage for £10. Was that contained in the Articles of Association? In his (the Vice-Chancellor's) opinion it was a clear "fraud," and when he said "fraud" he meant in the sense that all acts *ultra vires* are fraudulent, not otherwise. The transaction, in his opinion, was wholly invalid, and had the meeting been duly convened and the minutes been properly signed, and had it been the intention of the company to raise £10 on each of the debentures to the extent of £20,000, the transaction would have been inequitable and invalid, and altogether outside the duties of the directors, and have been one of those contrivances, which are so numerous, by which witless people, who had trusted their stakes to the company, would play the gambling game for them, be cheated of their stakes, and secure nothing but counters in return. That was enough to decide the case, and upon that ground he proposed to dismiss the action, with costs, as a fraudulent contrivance not authorised by the Articles of Association, and by common sense and justice and for every reason invalid. He did not find it necessary, therefore, to go into

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the Bills of Sale Act; he relied solely upon the deed which had been executed by the directors. As to the directors having determined to borrow £20,000 for the purposes of the company by the issue of debentures at £10 each, that was not the suggestion of the "Doctor's," and there was not a shadow of an intention to borrow £20,000; but they meant to beguile the shareholders to think that they were bettered in their position by getting a mortgage for £10,000 by paying another £5. He did not think it necessary to go into the Bills of Sale Act. The 17th section of that Act was no doubt a very wide and sweeping section; but, whatever the effect of it might be, was wholly outside the matter now before the Court. In this case, where the interests of the shareholders were placed under the protection of the Court, the question was whether the Company was bound by a deed executed by three persons, and executed in such circumstances as were wholly opposed to the true interests of the shareholders, and therefore he dismissed the action with costs.

Mr. MARTEN said that plaintiff had nothing to do with the creation of the debentures, He simply bought the debentures at par, and represented the creditors who had taken the debentures, therefore his Lordship would be punishing an innocent person by making him pay the costs. He submitted that it would only be fair that the costs should come out of the estate.

The VICE-CHANCELLOR said the so-called "innocent" person came to try and make the shareholders pay that which he had no right to demand, therefore he did not hesitate for one moment in dismissing the action with costs. As to the trustees, they were confederates, and he should therefore give them no costs.

COMPANIES' MEETINGS & REPORTS.

Western and Brazilian Telegraph Company.

The twelfth ordinary general meeting of the shareholders was held on Thursday at the City Terminus Hotel, Cannon-street, Sir Henry Drummond Wolff, G.C.M.G., K.C.B., M.P., in the chair.

Mr. R. M. CUNNINGHAM read the notice convening the meeting and the minutes of the preceding meeting, which were confirmed. The report and accounts were taken as read.

The CHAIRMAN: Gentlemen, you will have seen by the report and accounts that the revenue this year unfortunately shows a diminution of £6,500 odd. This is principally owing to the interruption that took place in the Brazilian Submarine Cable lines, by which we lost about £20,000, or between £20,000 and £25,000; but notwithstanding that, owing to the new arrangements that have been made, I am happy to say that the nett loss was nothing of that kind. Fortunately the Brazilian Submarine Company, with great spirit and energy, proceeded not only to re-lay the line that was broken but they duplicated it, and, therefore, I hope that hereafter we shall have no interruption in the principal feeder of our own line. It may be interesting to the shareholders to know that the reduced tariff at which we are now working has answered remarkably well. I will give you a short statistic of the messages and words which we now carry in comparison with those which were carried previous to the new tariff. In 1882 we carried 44,989 messages of 373,966 words; in 1883 we carried 48,259 messages with 401,782 words; but in 1884 we have carried 101,692 messages with 969,814 words. Thus you see an enormous increase, and that the traffic has considerably more than doubled itself. Well, in the year 1883 the Company carried 57 per cent. of the international traffic, and the Government carried 43 per cent.; but in the year ended September, 1884, the Company carried 90 per cent. of the international traffic and the Government lines only 10 per cent.; and I am happy to say that in the first quarter of this year we have to a great extent recouped ourselves in the losses that unfortunately took place last year, for in the first 16 weeks we have got a traffic of £45,000, against £21,000 last year. Of course the small amount last year was owing to a great extent to the breakage; but that shows a clear gain this year of £24,000. But even on the year before, when there was no breakage, our traffic shows an increase in the first 16 weeks over the traffic in the same period of the year before last of £5,746, notwithstanding that we have reduced our tariff so considerably. Therefore, on the question of traffic and on the question of receipts, I think that the Company has good cause to congratulate itself. Against this excess in the receipts there has been no proportionate increase in the expenses; the increase has only been very slight; but unfortunately we still have to spend a great deal of money on maintenance and the ships. No doubt the ships cost us a good deal of money, but, on the other hand, the presence of the ships there has greatly aided us in the repairs we have had to make, and we have not only made very great repairs, but we have entirely relaid a large portion of our line—to the extent, I think, of 382 miles. This has reduced our unrenewed cable, if I may so call it, to only 450 miles out of our whole system of 2,500 miles. We thought for a long time that this unrenewed cable, which is what I believe is called a deep ocean cable, which is laid in deep water, was safe in the deep sea, so long as it did not come near land; but unfortunately we have discovered that such was not the case, and, therefore, we considered it absolutely necessary for the safety of our system to relay as much as we could last year. The whole system, therefore, consists now of 2,050 miles of sheathed cable, and only 450 miles of the old type, and I think it will be our duty and our policy gradually to go on relaying it until we have nothing but sheathed cable. I do not want to go into past history; but at the same time the shareholders know very well that the present Board is not responsible for the inferior type of cable, and that we, therefore, are really working a rather uphill game in having constantly to spend money on renewing the cable laid in the first instance. The attention of the Board has been very much turned to the question of expense with regard to the ships. As I said before, those ships are and have been perfectly indispensable, and have been very useful to us in enabling us at once to send necessary appliances for the repairing of breakages, as well as for the laying of new cable; but it will also interest the shareholders to know that with the laying of the new cable we expect to have comparatively little repairs; and that in the cables laid South of Rio de Janeiro, which are all sheathed, an expenditure of about five miles per annum appears to be all that is necessary to cover the repairs. Of course there may be accidents, such as those caused by the bad bottom of the sea, or the anchors of ships; but we anticipate that where the sheathed cable lies that is about the portion required for repairs. Now, having come to this point, I wish to say one word on a subject which is not particularly agreeable—it is that of the dividend. Now, no doubt—

Mr. BAKER: You mean the non-dividend.

The CHAIRMAN: Well, the non-dividend, if you like that better [laughter]. But, of course, the shareholders must see that nothing could be more agreeable to the Directors than to be able to declare a dividend if possible [hear, hear]. In fact the objects and the interests of shareholders and Directors are identical.

A SHAREHOLDER: They ought to be certainly.

The CHAIRMAN: Well, I hope they are [a Shareholder: Question]; but at the same time we, the Directors, sitting on this side of the table, who know the state of the Company, the state of its finances, and the state of the cable, have a great responsibility to discharge, and I do not think we should be right in shrinking from it. Therefore, we unhesitatingly say this year that for the interest of the Company, and for the prosperity of the Company, it would be better to pay no dividend [a Voice: Question].

The CHAIRMAN: I think I am speaking to the question [hear, hear].

Mr. BAKER: It is a matter of opinion.

The CHAIRMAN: I think I have the right to use any arguments I think necessary to support my view.

Mr. BAKER: We may differ on this side of the table.

The CHAIRMAN: I shall be delighted to hear you. If you differ from me we will discuss the matter and come to an agreement; but at the same time the shareholders must be aware, as I said before, that studying constantly and throughout the whole year the state of our property we have reasons to arrive at the decision to which we have come. There are a great many differences of opinion as to what is called the life of a cable, and I will not go into that now, because it is rather a long and moot question; but, at the same time, with these views and with the opinions with which we have been fortified by experts and by legal opinion, we think it absolutely necessary that our renewal fund should not be lowered below a certain sum; and as this year we have had to diminish our renewal fund to a considerable extent by reason of the repairs—that is to say, to the sum of £36,000—we think it absolutely necessary to replenish our renewal fund with the £15,000 which might have been applied to a dividend had we considered it right to do so. Therefore, the Directors have not considered it right to recommend a dividend now; but at the same time they think that by this recommendation of theirs—or non-recommendation of theirs—the prosperity and the substantial welfare of the Company is more assured than by giving so very small a sum to the shareholders [hear, hear]. This sum of £15,000 is not paid to the shareholders, but it is no less theirs. It goes to the renewal fund; it goes to the maintenance of their property, and having regard to this, I can only say that to my mind the Company has a very prosperous look out. We have repaired the line, as I have told you, to a very great extent; we have the duplication of the lines of the Brazilian Submarine; we have a large increase of traffic, and we also have a very substantial reserve fund. [Hear, hear.] Therefore, with these four advantages, though I excessively regret that this year we are unable to keep up the dividend, I confidently recommend the report to the adoption of the shareholders. There is one more point I should like to say one word on, and that is with regard to the negotiations which are now going on between the Government and ourselves. Well, I think the policy we adopted in reducing our tariff has, as you see, been successful, and I know that the attention of the Brazilian Government has been directed to the necessity of some understanding with us. I believe this year we are likely to receive in England the visits of certain Brazilian officials, who will be probably empowered to go into the question of some arrangement between us; but until then I think the least said the better, inasmuch as it is useless to raise hopes, which, perhaps, may not be carried out. The negotiations are still being actively carried on, and I trust they will end successfully some day or other. With these remarks, gentlemen, I will move, "That the report and balance-sheet to the 30th September, 1884, be and the same are hereby received and adopted," and I shall be very happy to answer any questions which may afterwards arise.

Mr. W. S. ANDREWS seconded the motion.

Mr. HERRING referred to the rumours which had been circulated before the report was sent out, that no dividend would be paid, and said that although he had read the report very carefully he failed to discover any reason why the profits earned should not be divided [hear, hear]. From beginning to end the report seemed to take the black side of things, and there was an entire absence of the *couleur de rose* element which was usually to be fouud in directors' reports. Amongst other things it was stated that the depreciation of the ss. "Viking" amounted to £1,129; but no special mention had previously been made of such a matter in the reports.

The CHAIRMAN: We did not have the "Viking" before.

Mr. HERRING: Then, why put it here now?

The SECRETARY: Because the depreciation is £1,100 more than last year.

Mr. HERRING then went on to criticise the tone of the report, and said

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there was no pretext for keeping the shareholders out of a dividend, seeing that £36,000 had been laid aside for the express purpose of converting the strand cable into a sheathed cable. He also considered that the expenses might be cut down. If, however, the Directors intended to use their proxies he would not move an amendment. Would they do so?

The CHAIRMAN asked whether the amendment would be to the effect that a dividend should be paid?

Mr. HERRING replied that he would simply ask the Directors to reconsider the matter.

The CHAIRMAN said, in view of the strong expression of opinion they had had from the shareholders on this question, the Directors would use their proxies in the event of a poll being demanded [hear, hear, and no, no].

Mr. HERRING, after an interruption, moved as an amendment "That this meeting do not adopt the report, but requests the Directors to reconsider the question of the payment of a dividend."

Mr. DYER seconded the amendment.

Mr. CHAPPELL contended that a dividend of at least 2½ per cent. should be paid on the preferred shares, which would absorb £12,000. He asked if the cable in hand, which was put down at £22,000, was of the sheathed type available for present practical purposes.

The CHAIRMAN: Yes, it is.

Mr. SUTTON also advocated the payment of a dividend, and suggested an amendment to the effect that a dividend of 2½ per cent. should be paid on the preferred shares.

The CHAIRMAN pointed out that such an amendment could not be put as it would be out of order. The Articles of Association provided that the shareholders could not increase the dividend recommended by the Board, but they could reduce it.

Mr. DYER protested against the system of sending out stamped proxies.

Major COTTON thought the Directors as large shareholders would have been only too glad to be paid a dividend if they could do so consistently with the interests of the Company [hear, hear]. It was very satisfactory to see that the work done had been so largely increased with only a slight increase in the expenses, and in face of the facts stated by the Chairman, he thought it would be most unwise to press the matter of a dividend to an issue, even if it could be legally done.

Mr. BAKER moved an amendment:—That the sum of £13,000 should be devoted to the payment of a dividend.

In the course of some further discussion, the policy of the Board was supported by Mr. WHITE and Mr. CHALLONER SMITH.

The CHAIRMAN pointed out that the renewal fund had really been built up out of a return of capital, and they had the opinion of Mr. Horace Davey, Q.C., that it could not be appropriated to the payment of a dividend; but besides this the renewal fund as it stood was only just sufficient to maintain the line if the whole of the cable were sheathed. They had 3,000 miles of cable which they were bound to renew sooner or later.

Major WOOD (managing director) said the Directors could not have foreseen the breakages that had occurred 2,000 fathoms below the sea level, nor were they responsible for laying the old strand type of cable. It was most important that the renewals should be effected as rapidly as possible, and therefore, even if the funds in hand could be legally divided, he thought it would be most unwise to do so [hear, hear].

After a few remarks from Mr. ANDREWS,

Mr. HERRING withdrew his amendment, and

The CHAIRMAN ruled that the other amendments were out of order, and declined to put them.

The motion for adopting the report and accounts was put, and declared to be carried.

The retiring Directors, Messrs. Earle and Weaver, were re-elected, and Mr. Weise, the retiring auditor, was reappointed.

The Eastern Telegraph Company.

Report and accounts of the Directors for the half year ended 30th September, 1884, to be presented to the twenty-fifth half-yearly ordinary general meeting, to be held at the City Terminus Hotel, Cannon-street, on the 29th inst., at 1 o'clock.

The Directors submit the accounts and balance sheet for the six months ended 30th September, 1884. The revenue for the period amounted to £309,569 17s. 3d., from which are deducted £84,907 7s. for the ordinary expenses, and £31,189 1s. 3d. for expenditure relating to repairs and renewals of cables, &c., during the half year. After providing £4,439 1s. 7d. for income tax, there remains a balance of £189,034 7s. 5d., to which is added £2,605 11s. 10d. brought forward from the preceding half year, making a total available balance of £191,639 19s. 3d. From this balance there has been paid—Interest on debentures, debenture stock, &c., £26,716 11s. 3d.; dividend on preference shares, £20,559 2s. 6d.; two interim dividends of 1½ per cent. each on ordinary shares, with bonus of 1s. per share (½ per cent.), £114,000, leaving a balance of £30,364 5s. 6d., which is carried forward to the next account. The revenue includes £15,600 dividend for the half year upon the Company's shares in the Eastern and South African Telegraph Company, being at the rate of 8 per cent. per annum, and also £2,023 3s. 5d. net receipts for the half year on the shares of the Black Sea Telegraph Company belonging to this Company. The several sections of the Company's cables, and the land lines in connection therewith, continue in good working order. The building of the new cable steamer "Electra," to replace the "Retriever," was entrusted to Messrs. R. Napier and Sons, on their tender. The ship was successfully launched on the 19th instant. The establishment of telegraphic communication between the islands of the Greek Archipelago, referred to in previous reports, in accordance with the agreement with the Greek Government, was completed by the Company's ss. "Volta" on the 9th August last. A supplementary Convention has been signed for the connection by submarine cable of several other Greek islands. The Directors have concluded an agreement, under a guarantee of traffic, with the Perim Coal Company (Limited), for the connection of the island of Perim with Aden and Suakim by one of this Company's Red Sea cables. The new station was opened for traffic on 31st October. It is expected that the island will become an important coaling station. The Italian Government have now officially approved the transfer to this Company of the concessions and cables of the Mediterranean Extension Telegraph Company, purchased with the sanction of the extraordinary general meeting held on the 24th of January last, and £35,000 of the Company's 4 per cent. debenture stock, the agreed price, has been issued to the liquidators. The action brought by the Central News, Limited, against this Company and others, referred to in the last report, has been finally stayed, all parties agreeing to pay their own costs. In accordance with the provisions of the Articles of Association, two of the Directors, John Pender, Esq., M.P., and the Marquis of Tweeddale, retire by rotation at this meeting, and, being eligible, offer themselves for re-election. The Auditors, Mr. Henry Dever and Messrs. Quilter, Ball, and Co., retire, and offer themselves for re-election.

Cuba Submarine Telegraph Company.

Report of the Directors for the half year ended 31st December, 1884, to be presented at the twenty-seventh ordinary general meeting of shareholders to be held at the Company's offices, 61, Old Broad-street, E.C., on January 28.—The Directors submit, duly audited, the balance-sheet and accounts for the half year ended 31st December last. From these it will be seen that the gross receipts, including the balance brought from last account, amount to £15,710 8s. 10d., and the gross expenditure, including the half of the annual payment on account of the 1881 cable, to £6,119 15s. 4d., leaving a sum of £9,590 13s. 6d. to the credit of revenue account. Of this the sum of £550 has been added to the reserve fund, increasing that fund to £60,000. The dividend on the preference shares will absorb £3,000, and leave £6,040 13s. 6d., out of which the Directors recommend the payment of a dividend on the ordinary shares at the rate of 7 per cent. per annum, free of income tax, the balance, £440 13s. 6d., being carried forward to the current half year's account. The Directors have much pleasure in reporting that all the cables have continued in good working order, with the exception of one of the harbour lengths at Cienfuegos, which has become worn out. A new spare length, it will be remembered, was laid in the beginning of last year. A piece of ground has been purchased at Cienfuegos, upon which a store has been built to contain the machinery for the repair of picked-up cable. Tanks have also been fitted up therein for the reception of spare cable. The tax to be returned by the Spanish Government, referred to in last report, has not yet been received.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. JAN. 21.		BUSINESS DONE WEEK ENDING JAN. 21. Highest.		Lowest.	
Anglo-American	30½,	31½	.....	30⅞	.....	—
Do. Preferred	54½	55½	.....	55½	.....	54⅞
Do. Deferred	7⅞,	8½	.....	8½	.....	7⅞
Brazilian Submarine	10⅝,	10⅞	.....	10⅞	.....	10 11-16
Cuba	11,	11½	.....	—	.....	—
Do. Preference	17½,	18½	.....	—	.....	—
Direct Spanish	2,	2½	.....	2	.....	—
Do. Preference	10,	11	.....	10½	.....	10½
Direct United States Cable	9⅜,	10	.....	9⅞	.....	9⅞
Eastern Telegraph	11½,	11⅝	.....11 13-16		.....	11 9-16
Do. 6 per Cent. Preference	13⅞,	14½	.....	14½	.....	14
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	12½,	12½	.....	12⅝	.....	12½
German Union	9½,	10	.....	9⅞	.....	—
Globe Telegraph and Trust	6⅞,	7	.....	7	.....	6⅞
Do. Preference	12½,	12⅞	.....12 11-16		.....	12 7-16
Great Northern	14½,	14⅞	.....	15	.....	—
Indo-European	32,	33	.....	32⅝	.....	32
Reuter's	7½,	8	.....	—	.....	—
Submarine	175,	180	.....	180	.....	—
West India and Panama	⅝,	¾	.....	¾	.....	¾
Do. 1st Preference	7½,	7⅞	.....	7 5-16	.....	7½
Western Brazilian	6,	6½	.....	6 3-16	.....	5⅞
Western Union 7 per Cent. 1st Mortgage	120,	125	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	.....	—	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	.....	½	.....	—
Oriental	⅛,	⅜	.....	—	.....	—
United Telephone	11½,	11¾	.....	11⅝	.....	11⅝

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1½	.....	1⅝	.....	1½
Do. (fully paid)	3½,	3¾	.....	—	.....	—
Hammond Light (£3 15s. paid)	⅝,	¾	.....	¾	.....	11-16
Swan	⅛,	⅜	.....	—	.....	—
Maxim-Weston	3-16,	5-16	.....	5-16	.....	—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	.....	35½	.....	34½
India Rubber, Gutta Percha, and Telegraph Works	21,	22	.....	21¾	.....	21⅛

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NOTES.

ATLANTIC CABLES.—The cable of the Paris and New York Telegraph Company is still interrupted.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 23rd January amounted to £3,859.

MACKAY-BENNETT CABLE.—The duplexing of the second Mackay-Bennett cable is now finished, and the Havre section is expected to be laid at the beginning of next month.

COMMUNICATION WITH THE FASTNET.—The cable from the mainland to Lloyd's signal station on the Fastnet Rock has been successfully laid, and vessels signalling that station can now be telegraphed to their owners direct from the rock.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 23rd January were £3,114, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

ELECTRIC TRAMWAY FOR BLACKPOOL.—The Blackpool Electric Tramway Company with a capital of £30,000, in £10 shares, is being actively promoted by some Lancashire gentlemen. The proposed line is to run from the south shore to the north shore.

INTERNATIONAL TELEGRAPH CONGRESS AT BERLIN.—This conference, which was to have been held at the beginning of the present year, is postponed to 10th August, 1885. Official invitations will be issued to all who took part in the St. Petersburg meeting.

ELECTRIC LIGHT AT FRANKFORT.—The first application of the electric light at Frankfort-on-the-Main was made at the recently opened Bauer *café* with 167 Swan lamps fitted to the gas brackets, current being supplied by a Weston dynamo driven by a 20-horse gas engine.

NATIONAL TELEPHONE COMPANY.—We have received the first issue of the list of subscribers to this company in the Inverness district. There are already 46 subscribers in this new district; and three indices, numerical, alphabetical, and classified, have been compiled.

THE DIRECT UNITED STATES COMPANY.—The Board has resolved upon the payment of an interim dividend of 5s. per share, being at the rate of five per cent. per annum for the quarter ending 31st December, 1884, such dividend to be payable on and after the 16th February next.

EASTERN TELEGRAPH COMPANY.—This company notifies that the coupons on their Five per Cent. Debentures due on 1st February will be paid after that date at the banking house of Messrs. Glyn, Mills, Currie, and Company, 67, Lombard-street, London, E.C. Coupons must be left three clear days for examination.

PERSONAL.—Mr. E. J. Erskine, a young electrician, who has been engaged upon the electric light installation for the King of Roumania's country seat at Linia, also at the Bucharest Palace, received, on New Year's Day, a royal recognition in the shape of a gold pin, set with diamonds, and engraved with the king's initials and a crown.

"THE SPECIALISTS' SERIES."—The second volume of this series on "Gas Engines," by William Macgregor, edited by Drs. Paget Higgs and Charles Forbes, will be published next week. There has, we understand, been a delay in issuing this volume, owing to desire to obtain the latest information concerning the most recent motors.

ALTERNATE-CURRENT MOTORS.—The conclusion arrived at by M. Hospitalier in an article on this subject in *L'Electricien* is that alternate currents may produce mechanical work like continuous currents, whether synchronism be insisted upon or variable speed be admitted; but in both cases alternate currents are less convenient and less economical than continuous currents.

ALUMINIUM FOR LEYDEN JARS.—Mr. Levison suggests that aluminium, which may now be beaten out into sheets as easily as gold or silver, be used for lining Leyden jars, the sheets being, of course, thicker than the tinfoil now employed. For an equal surface it would not cost more, would be lighter, and would retain its brilliancy. Fifty sheets of aluminium foil, 4 square inches in surface and of the suitable thickness, would cost about 4s.

DIRECT UNITED STATES CABLE COMPANY.—This Company's main cable between Ireland and Nova Scotia is interrupted. From particulars to hand the cable appears to be broken about 330 knots by cable from Torbay, Nova Scotia, in shallow water, and, weather permitting, easily repairable. During the interruption the company will continue to accept telegrams marked "*vid* Direct Cable," which will be transferred to the Anglo-American Telegraph Company.

POSTAL TELEGRAPHISTS.—We have again to chronicle a festive meeting of postal *employés*. Last week the Worcester postal and telegraph officials held their sixth annual gathering, when good cheer and good wishes ruled the roast. In the course of the evening reference was made to the great increase in the number of telegrams dealt with at this office, no less than 10,000 messages having passed through last year in excess of the number recorded for the previous year.

ELECTRIC LIGHT AT THE CESSNOCK GRAVING DOCK.—Last week the new graving dock and entrance quay to the new Cessnock Docks, Govan, in course of construction, were illuminated by the electric light. The installation, which consists of five Crompton lamps of two thousand candle-power, has been installed by Messrs. Henry Bennett and Co. By means of this light, which is reported as being very satisfactory, the work of constructing the dock will be carried on at night.

ELECTRICAL NOMENCLATURE.—Herr Uppenborn protests warmly, in the *Centralblatt für Elektrotechnik*, against the use of proper names to express electrical measures, saying that if chemists and mechanicians follow in the same direction we may expect to read such items of news as the following:—The boiler of Messrs. X. and Y. burst at a pressure of 100 stephensons; the steels of the A establishment stood an impact of 2,500 trescas; the solubility of ammonia equals 3,000,000 peligots, and so forth.

THEORY OF ELECTRO-DYNAMIC INDUCTION.—At a recent meeting of the Académie des Sciences, Paris, M. Hermite presented a paper by M. P. Duhem on this subject, in which he demonstrates that:—(1) All forces not dependent on distance are annihilated, (2) all action which depends on distance has an infinitely small resultant, and (3) elementary couples are constituted so as to give to the end of each element of length of the conductor a force of the same order as the

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element, and a finite force at the points where the form of conductor presents a singularity.

ELECTRIC LIGHT IN CALIFORNIA.—This week's *Electricité* illustrates the pyramidal towers made of gas pipes for lighting the town of San José, California. The tower is quadrilateral, the side of the base being about 80ft., while the side of the square at the top is only 4ft., the height being nearly 200ft. The tower is surmounted by a disc, which protects the lamps, and also reflects the light downwards. The six 400-candle Brush lights, supplied by the California Electric Light Company, throw a light that does not dazzle the eyes over a large area, which is better illuminated than by the former gas-burners placed 80ft. apart.

LIGHTING FOR THE "EXMOUTH." — The Metropolitan Asylums Board, 37, Norfolk-street, W.C., announces that it is prepared to receive schemes, specifications, and tenders for lighting by electricity the training ship "Exmouth," now moored in the River Thames, off Grays, Essex. The vessel may be inspected on any week day between 10 a.m. and 4 p.m. by those interested. Sealed tenders, which should state the estimated annual expense of maintenance as well as the actual cost of installation, must be delivered at the offices of the Board, 37, Norfolk-street, Strand, by Saturday, the 14th February, at the latest.

THE WHEELERIES.—Under this designation a large marquee has been pitched on the Thames Embankment for an exhibition of cycles (both bi- and tri-), which opened on the 28th January, and will be continued for about a week. In the evening Mr. Webster, of Maldon, shows some 2½-candle incandescent lamps, maintained by Emmens' portable battery, and adaptable to any kind of tricycle lantern. The electrical bicycle has not put in an appearance this year, probably because the existing restrictions, that every vehicle propelled by other than animal power must be preceded by a person waving a red flag, are too stringent for its general adoption.

ELECTRIC LIGHT AT MADRID.—*L'Electricien* says that a central station is to be established near the Salamanca gate of the Spanish capital for supplying the current necessary to light the greater part of the city. In the ground floor will be the steam engine, dynamos, and workshops, while the upper floors will be taken up with offices and *employés'* residences. There are to be fifteen 100-horse and eight 250-horse engines, with two dynamos calculated to produce, at 150 revolutions a minute, a current of 120 volts at 10,000 amps. The main conductors, of best copper, will be laid underground, their sectional area being calculated for 3 amps. per square millimetre.

ELECTRIC LIGHT ON THE CLYDE.—The No. 2 Graving Dock Works of the Clyde Trustees are being supplied with electric light by Messrs. Henry Bennett and Co., of Glasgow, and the work of construction is being carried on night and day. There are five arc lamps of 3,000 candle-power, three of which light the dock itself, and the other two, hoisted on poles 50ft. high, light the space where the concrete-mixing and concrete cylinder-making is carried on, and the cutting at the dock entrance. The dynamo is driven by a Robey portable engine, and the engine house and approach to it is lighted by a small Grove patent dynamo, supplying currents to five Bernstein incandescent lamps of 30 candle-power each.

SECONDARY BATTERY PATENTS.—Two important and interesting cases with reference to secondary battery patents in the United States have recently been decided. Interferences were raised by Starr and Brush against the Sellon and Swan patents, which belong to the Electrical Power Storage Company; and in both cases the fight has been most obstinately and at great cost contested for nearly two years, appeal after appeal having been heard. The results of the last appeals are that priority of invention has been awarded to both Sellon and Swan as against Starr and Brush. As against Brush the decision on this last appeal is absolutely final, but in the case of Starr a further appeal is still possible.

ELECTRIC TRAMCARS.—Application having been made to the Wandsworth District Board of Works to sanction an experimental electrical car being run on the tramway through Battersea, Mr. Morton moved, at the last meeting of the Board, "That before the consent of the Board be given to the proposal to run electric cars on the tramways, the opinion of an independent engineer or expert be taken, and that the engineer engaged do attend the General Purposes Committee on their visit to inspect the said cars, the fee and expenses of the engineer not to exceed the sum of £10 10s., and such fee and expenses to be paid to this Board by the parties making the application." After a long debate the matter was referred to the General Purposes Committee, with power to act.

METRICAL ABBREVIATIONS.—In commenting on the eight pages of tables relating to electricity and electrical units, added to the *Annuaire du Bureau des Longitudes*, and which are said to be perfectly correct though very incomplete, *L'Electricien* complains that the *Annuaire* does not conform to the indications given in these tables. Our contemporary makes the same strictures as to the metrical abbreviations, which are by no means in conformity with the decisions of the International Committee of Weights and Measures, asking "Of what use are committees, conferences, and congresses if their work is ignored?" But "glass houses should not throw stones." We find, in the same number of *L'Electricien*, that a point is put after the metrical abbreviations, whereas, if we remember rightly, the international committee decided that they should be printed without the point.

ARTIFICIAL GUTTA PERCHA.—This substance is made in the following manner: 50 kilogrammes (110lb.) of powdered copal, with from 8 to 15 kilogrammes (17½ to 33lb.) flowers of sulphur, are raised to a temperature between 126° and 150° C. (259° and 306° F.) with double the weight of turpentine, or with 50 to 60 litres (11 to 13 gallons) of paraffin, being constantly agitated until completely dissolved. To this are added 8 kilogrammes (17½lb.) of caseine dissolved in weak ammonia mixed with a small quantity of alcohol and wood spirit; and the whole is allowed to cool down to 38° C. (100° F.), being again heated to a temperature of from 126° to 158° C. (259° to 306° F.) until it has the appearance of a light liquid. It is then boiled with a solution containing from 15 to 25 per cent. of tannic acid and 500 grammes (1·1lb.) of ammonia. It is kept boiling for several hours, allowed to cool, washed with cold water, and then kneaded in warm water, when it is dried so as to be ready for use.

LIGHTING BY ACCUMULATORS.—Some of the shops in the Passage des Panoramas, Paris, are now lighted by fifty Woodhouse and Rawson 10-candle incandescent lamps, giving out 0·7 amp. at 40 volts, maintained by 22 Faure-Sellon Volckmar accumulators, charged by a Gramme shunt-excited dynamo, driven by a 4-horse Otto gas-engine. The installation was made by Liepmann Frères; and the following are given by *L'Electricien* as the advantages attending the use of accumulators:—(1) Whatever may be the irregularities of the motor, the current

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sent through the lamps is perfectly constant; (2) the motor always works up to its full power, and therefore economically, whatever be the number of lamps in circuit; (3) the engine need not work all the time the light is required, but only so long as may be required to recharge the accumulators. At present the subscribers are only charged at gas rates for an equal light; but it is hoped that the lighting will be extended throughout the arcade, when the charge will be made by meter.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The Board of Directors has resolved, after placing £37,500 to the credit of the Renewal Fund for the quarter ending 31st December, 1884, to recommend to the proprietors at the next half-yearly general meeting of the company, to be held on the 6th February next, the declaration of the following dividends:—1. A balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ending 31st December, 1884. 2. A balance dividend of 30s. per cent. upon the preferred stock for the year ending 31st December, 1884. 3. A first and final dividend of 5s. per cent. upon the deferred stock for the year ending 31st December, 1884. All payable on 7th February next. After paying the foregoing dividends there will be a balance of about £1,500 to be carried forward to the next account. The above dividends, together with those already paid, will amount to £3 2s. 6d. per cent. on the ordinary consolidated stock, £6 per cent. on the preferred stock, and 5s. per cent. on the deferred stock for the year 1884.

TRAIN LIGHTING BY ELECTRICITY.—While the Great Eastern Railway Company with commendable enterprise has carried on electric lighting in some of their suburban trains for months past, and a battle of words is now raging in the pages of a contemporary with reference to this particular system of train lighting, German electricians have not been idle, and have fitted up some trains on the Frankfort-Fulda-Elm line with a dynamo placed in the guard's van on one side and accumulators on the other side. The dynamo, if driven at 750 revolutions, gives a current of 12 amperes, which by an automatic switch is sent into the accumulators. Since the dynamo is driven from one of the axles of the van, it can only charge when the train is in motion and going at a speed of over twenty miles an hour. If the speed falls below this minimum the switch cuts the dynamo off from the accumulators in daytime and from the lamps at night, since during the evening the lamps are fed direct from the machine so long as the train is in motion. On stopping, the automatic switch not only cuts the dynamo out but also puts the accumulators in, thus insuring the continuation of the light at all times. The cost of installing the plant is given at £125 for dynamo, driving gear, and accumulators, and at 65s. to 80s. per passenger coach. The light itself is estimated to cost ·85 of a penny per lamp-hour.

TRANSFER OF CARBON IN THE ELECTRIC ARC.—M. G. Gallice, in *L'Electricien*, says that a simple experiment makes manifest the transfer of carbon particles from one electrode to another in the voltaic arc. If the arc be produced by taking as the negative electrode a carbon 15mm. in diameter, and as the positive electrode a 4mm. carbon, the following phenomenon will be observed:—The negative carbon does not become red hot on account of its volume; but, on the contrary, the positive carbon immediately becomes incandescent and pointed. By degrees the particles of carbon which escape from it are deposited on the negative carbon and there form a small cone, 3mm. in diameter at its base and attaining nearly 4mm. in height, which is continually increasing. It then behaves as would the point of the negative carbon in the ordinary arrangement, with this difference, that the wasting due to combustion is compensated by the deposit of carbon. The light is at this moment brighter than at the commencement, and remain very constant. The cone sometimes breaks, but is soon reconstituted, being formed of a very black carbon, with fine and brilliant fracture, but having less cohesiveness than lighting carbon. A projection of the carbons by means of the photo-electric microscope renders the experiment interesting to follow. The author used a rougly-made Archereau lamp, the luminous point of which is sufficiently constant for optical experiments, while its simplicity and the absence of regulating apparatus render it preferable to hand-regulated lamps, which are often used under similar circumstances.

PROPORTIONAL DEVIATION GALVANOMETER.—In the Deprez and D'Arsonval galvanometer for movable circuit, there is only proportionality between the intensities and the deviations when an angle of four or nine degrees is not exceeded. So that it is always necessary to resort to the mirror when using this instrument; and that is not always convenient, especially in applications of an industrial character. M. Marcel Deprez, in seeking to construct apparatus for electrical measurements, at once simple, correct and of speedy application, has modified the original galvanometer so as to render the deviations exactly proportional to the intensities, even when they attain sixty degrees on each side of zero, which permits of using an index fixed to the movable frame, and working above a graduated sector. The modification made in the original instrument consists in providing the arms of the magnet with two pieces of iron forming between them a cylindrical recess in which is placed the soft iron cylinder. The space between the latter and the two polar pieces forms an intense magnetic field, practically uniform, in which the frame moves. Whatever be its position within the above-mentioned limits, the couple due to the current is always proportional to its intensity; as, on the one hand, the couple due to the suspension wires is proportional to the angle of torsion, it follows that equilibrium is attained whenever the frame has made an angle proportional to the intensity of the current which traverses it. Experiments made in comparison with voltametric methods have proved that, from zero to 60 degrees, the galvanometric constant, *i.e.*, the intensity corresponding to a deviation of 1 degree, varied by about 1 per cent. of its mean value, a quantity of the same order as the other causes of error inseparable from the method of comparison employed.

THEATRE LIGHTING AT MUNICH.—It will be remembered that at the Electrical Exhibition in Munich an experimental stage was constructed and lit by electricity with a view to prove whether this form of illumination be suitable to theatres. The result of these trials, as far as Munich itself is concerned, has been an installation in the Royal Theatre, which is the largest installation yet erected in Germany, except the central station of the Edison Company in Berlin, which, however, is not a private but a public undertaking. The generating power in the Munich installation consists of five Edison dynamos, each capable of feeding 450 16-candle lamps for night work, and one Edison dynamo capable of feeding 250 16-candle lamps for use during daytime. These dynamos are driven by three compound steam engines developing together 350 horse-power. Three boilers, each having 930 square feet of heating surface, supply these engines with steam; and the grates are so arranged as to burn a poor kind of coal, found in Bavaria, and which is unsuitable for the manufacture of gas. The distance between the dynamos and the theatre is about 300 yards; and the current is con-

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veyed by four copper conductors laid one metre on the ground and taken back to the dynamos by four similar conductors placed by the side of the former. The total area of cross section in the mains is 1·9 square inch, which gives a density of current of about 800 amperes per square inch if all the machines are at work together. The total length of wire throughout the theatre is thirty miles; and the total number of sixteen-candle lamps fixed is 2,500. All the lamps are under control by means of one great central system of switches and rheostats, and several smaller switches and rheostats placed at convenient positions throughout the building. In this manner the most varied scenic effects can be produced, and provision is also made for putting arc lamps in circuit at various places when desired.

Delayed Demagnetisation of Iron.—Sig. Felici's experiments on the duration of magnetisation or demagnetisation were carried out by surrounding soft iron bars with two spirals, one magnetising and the other induced, capable of being opened or closed at very short intervals by the Felici interrupter. In the case of demagnetisation, if the magnetising current be interrupted at the very instant the induced circuit is opened, the induced current will correspond with the total amount of magnetism generated in the iron bar; but, if the induced circuit be only closed at the end of a certain time, t, after the interruption of the magnetising current, the induced current will only correspond with the residual magnetism preserved by the bar at the end of the time t. In this way, Sig. Felici found that the galvanometric deviation F, measure of the quantity of electricity in the induced current, might always be represented by a single exponent

$$F = A\,e^{-\alpha t} + B\,e^{-\beta t}$$

in which A, B, α and β are four constants. If the iron be almost perfectly soft, a single-term exponent will suffice. Sig. Stracciati, experimenting by the method and with the interrupter of Sig. Felici, proved the correctness of his (Sig. Felici's) results, and then turned his attention to ascertaining the influence of the degree of magnetising force, and that of the induced currents which may be developed in the iron mass, when he arrived at the following conclusions:—(1) Felici's formula reduced to a single term represents the results of the experiments so much better as the magnetising power employed is weaker; (2) the speed with which the magnetism of an iron mass is dissipated on the suppression of the magnetising force diminishes, at first rapidly, when this force increases, but it afterwards appears to tend towards a constant value; (3) the speed with which the magnetism is dissipated in a bundle of soft iron wires, which are prevented from touching each other by a few turns of silk only, diminishes appreciably when the conducting mass is rendered continuous by the aid of a mercurial bath in which the bundle is immersed.

Lighting a Mill by Electricity.—The experiment of lighting various rooms in a mill required for different manufacturing processes has been successfully carried out at the extensive woollen manufactory of Messrs. J. Taylor and Sons, Colne-road, Huddersfield. During the past year, and recently, the firm decided to largely increase the use of electric lighting in their works. The number of incandescent lamps in use for about twelve months has been 200, but Messrs. Taylor and Sons have now enlarged the area of lighting, and have just had put down a large Victoria Brush compound self-regulating dynamo, capable of lighting 700 or 800 incandescent lamps, and arc lights if required. At present they have 400 incandescent lamps of 20 candle-power each in operation in the warping, weaving, mending, knotting, and finishing rooms, the yarn store room, the pattern rooms, the warehouses and offices, as well as two powerful arc lamps. The dynamo is placed in the engine room, and is driven by the same engines that drive the general machinery of the mill. The power required to drive the electric machine is about forty horses. There are six circuits, each of which can be used separately from any of the others, and the supply to any of the six may be switched off whenever requisite. The result of the change from gas to electricity as a method of lighting is that in the rooms where the incandescent lamps are in use the air is purer, and there is no oppressive heat, while the lighting is all that is needed for the workpeople to perform by its aid the various operations required in the different manufacturing processes. In conversation the operatives say that they greatly prefer the electric light to the gas-light; that they could see to do their work better, and with greater comfort to themselves. The contractors for this increase of electric lighting of the works of Messrs. J. Taylor and Sons are Messrs. Thomson and Ritchie, who supplied the original installation, and who have entrusted the present work to Messrs. Woodhouse and Rawson, of 11, Queen Victoria-street, London, and it has been carried out under the superintendence of Mr. Reginald Laurence, A.M.I.C.E.

Electric Signals for Mines.—Mr. Sydney F. Walker, who has had much experience in applying electric signals to mines, considers that the most useful signal, and the one of which the greatest number are in use in collieries and iron mines, is that for engine planes. This consists of an electric bell and battery which are placed in the engine house, and two wires that extend from the engine house to the end of the plane, being connected to the bell and battery. For collieries, these wires are of naked galvanised iron, and, where the engine is on the surface, two wires are carried from the engine house down the shaft, being then connected to the wires on the engine plane. One of the wires in the shaft is of copper, covered with gutta percha. In both cases the signal is given by making connection between the naked iron wires at any part of the plane. The single stroke bell is the one most frequently used in mines, though sometimes, however, a vibrating bell is preferred. If required to signal at the end of the plane at the same time as to the engineman, the same battery and the same wires may be used to ring a second bell at that end, in which case the connection between one of the wires on the engine plane and one side of the bell is broken. The engine plane wire is left disconnected, the bell on that side being now connected either to "earth"—as the rails, the engine, &c.—or to a third wire, fixed for that purpose, extending to the end of the plane. This third wire, in this case, need not be insulated; but it may be stapled out of the way. At the other end of the engine plane, a second bell is connected between the wire which has just been disconnected from the bell in the engine-house and "earth" or the third wire. When connection is made between the first two wires, the current passes from the battery through both bells, returning either by "earth" or by the third wire, this third wire being necessary where the mine is very dry or it is difficult to maintain good "earth" at the end of the plane. It may be required to have a number of bells in different parts of the plane, all of which shall ring together, as before, from anywhere. The principal advantages of electric signalling for mines are stated by Mr. Walker as follows:—(1.) The signal is transmitted instantaneously. (2.) Any number of knocks may be made in rapid succession. (3.) Signals can be made to and from any number of places, all together, separately, or in any number that may be desired. (4.) The wires may be carried round curves, and in any direction, even in a tangle,

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without in the slightest degree affecting the efficiency of the signal. (5.) The wires once properly laid need no repairs. There is no consumption of material except in the battery; and that with proper insulation is very small indeed. (6.) These signals are easily kept in repair, far more easily than hand rappers. (7.) Telephones may be worked in connection with them.

STRANGE IF TRUE.—A curious example of the force of imagination is reported from Philadelphia. Dr. George C. Harlan, surgeon to the Wills Ophthalmic Hospital in that city, in the current number of the *Medical News* reports a curious case, showing the great influence of the mind upon the body, and the beneficial effects of a wooden magnet upon both. A young Philadelphia woman, Lizzie D. by name, applied at the Polyclinic, Thirteenth and Locust-streets, for relief from a disease of the tonsils. She was treated by Dr. Solis Cohen. Her disorder was attended with hysteria, and, like all hysterical people, the idea of being doctored filled her with delight. Shortly after her admission the nervous symptoms became more and more marked, and she was transferred to the care of Dr. Mills, the well-known neurologist. Five or six weeks previously she had had pleuro-pneumonia, and after that paralysis attacked the arms. This was cured, but the disease manifested itself in the legs and feet. Besides this there was a numb feeling in the lower part of the body, and twitching on the right side of the face, similar to that seen in St. Vitus' dance. Dr. Cohen applied a Charcot magnet in front of the ear. To his amazement the spasms on the side of the face touched by the magnet were greatly lessened in frequency and extent. It was evident that the cure was the result of imagination. After that she was attacked with eye troubles. At first there was no defect other than headache, after the prolonged use of the eyes, and some shortsightedness, but at length the right eye became, apparently, entirely blind, and muscular spasms of the most violent character disturbed not only the eye but the face and neck. She was sent to the Eye Hospital, and treated by Dr. Hansell. After several examinations, the Charcot magnet, that had proved so efficacious in the hands of Dr. Cohen, was applied to the defective vision, and with the most astonishing result. After many applications it occurred to Dr. Harlan that it would be a good idea to try the effect of unmagnetised iron of the same form and appearance of the magnet. A wooden "magnet" was procured, with iron tips, to give the metallic impression to the skin. It was placed in the drawer where the original Charcot instrument had been kept, and the patient was thoroughly ignorant of its character. Before the application it was noted that the pupil of the right eye was widely dilated, as in disease, and was perfectly rigid when exposed to a bright light. There was twitching of the muscles on the right side of the face. The application of the wooden magnet had a wonderful effect. Shortly after the painted wood was applied with much seriousness to her head, the twitching of the muscles stopped, and the face assumed its normal appearance. Gradually the pupil of the right eye became of the same size as the other, and freely responsive to light. The wooden magnet had triumphed. Dr. Cohen a short time ago had a case where the wooden magnet proved its efficacy. A patient of his fell down, and thought she dislocated her elbow joint. She was treated for that by a practitioner called in the emergency, and he discharged her with a stiff arm, which he said he was unable to straighten. Dr. Cohen examined the arm, and found no dislocation at all. He asked her to report at the surgical department of the Polyclinic for verification of his opinion. She called, and Dr. Steinbach noted extreme spasm of the biceps, the tendons being like whip cords. Dr. Cohen applied a wooden magnet, and the spasm relaxed at once.

BATTERIES FOR ELECTRIC LIGHTING.—The following is part of a letter which has been sent to a local paper, and is worth consideration. It was written by Mr. E. Dixon, of Hull, in criticism of an article in the *Eastern Morning News*, entitled "The New Electric Light." The writer says:—"The heading is well chosen to attract the eye, but on reading one soon sees that it is not a question of a new electric light but simply of a new galvanic battery with which to generate the current. This form of electricity is not applicable to the arc light, but only to the small incandescent lamps. This new battery is being well puffed in the papers, and as a large company is about to be got up called 'The Yorkshire Company,' a short criticism may prove acceptable. Let us concede that the description of the construction of this battery is correct, and that its properties, viz., the steady and continuous generation of a large volume of current is eminently suitable for a certain kind of electric light, where the use of the dynamo machine or any of the forms of accumulators is not practicable. Let us even for the sake of argument concede that it is the best and cheapest battery yet invented, and it will be at once seen that I have no wish to run it down. What I wish to do is to caution those too credulous people who believe all they read in print. The less means they have of judging, the more readily do they believe any statement connected with a new invention. Before investing on the strength of any prospectus, experience teaches most of us to be a little cautious. The public often see only the bright side first, the other side they get better acquainted with by experience, after they have lost their money. I think in this case there are reasons for caution. We are told that zinc at £14 10s. is put into the battery, and after it has done its work a production is obtained, used for making paint, worth £20 per ton, and that there is therefore 'a large margin to go on.' Very little account is taken of the cost of caustic soda or of the roasting for an hour or so the precipitated metallic copper necessary to reproduce the oxide. We are told 'there is a large margin to go on,' and many naturally conclude that the battery business leaves a fine profit, so that the electric light is produced for something less than nothing. I meet many people who have this impression, from having read this and many similar articles that have appeared. Now, though a believer in miracles, I am not able to believe that the first article ever supplied to the public for nothing or produced at a profit is to be the electric light. To produce the electric light by any other battery than the one advertised is admitted by electricians to cost about *ninety times* as much as to produce it by steam power and the familiar dynamo machine. We are therefore asked to believe that this new battery will be something more than ninety times cheaper than any yet invented, besides other advantages. You will say there is 'a large margin for our—what shall we say?—confidence in the new undertaking.' Without wishing to be unkind, it sounds rather too good to be true. Most men will perceive at once that a fallacy lies somewhere, just as it always does and always will when perpetual motion is discovered. In this case, as might be supposed, we shall find it in 'the large margin' where we are told zinc at £14 10s. produces a valuable product oxide of zinc at £20 largely used for making paint. Now, the best oxide of zinc used for making paint is worth from £17 to £18, and is not produced by precipitation. I never heard of the precipitate being used for paint grinding, and should be much surprised to hear of any manufacturer buying it at £10. It is not necessary to take up more space with roasting the copper."

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WILLOUGHBY SMITH.

SMITH, WILLOUGHBY, entered the service of the Gutta Percha Company in the year 1848, about which time Faraday first called attention to the wonderful electrical qualities of that then comparatively newly-discovered gum, gutta percha. Soon after this date the Gutta Percha Company commenced experimenting with a view to covering iron or copper wires with gutta percha for telegraphic or other electric purposes. In 1849 they had so far succeeded with these experiments that they undertook to supply thirty miles of copper wire covered with a thick coating of gutta percha, to be laid from Dover to Calais, with a view to practically demonstrating the feasibility of submarine telegraphy.

During the years 1849-50 Mr. Smith was busily engaged in the manufacture and laying of this line, an interesting account of which is given by him in his "Resumé of the Earlier Days of Electric Telegraphy," published in the *Journal* of the Society of Telegraph Engineers and of Electricians in September, 1881. The trouble and annoyance caused by the imperfect system of making the joints in the experimental line induced Mr. Smith to give this subject his special attention, and in the cable laid over the same course in the following year (in the manufacture and laying of which he was also engaged) he introduced a system of joint making which proved a great success, and in 1855 the present system of joining and insulating the conductor.

In 1852 he was engaged in the manufacture and laying of the Holyhead and Howth, Port Patrick and Donaghadee cables, and in the manufacture of the cables laid from Orford Ness to the Hague. In the same year Mr. Smith was also engaged in laying copper wires insulated with gutta percha in a trench dug in the "six-foot" of the Lancashire and Yorkshire Railway between Manchester and Liverpool. This was the first line possessed by the Magnetic Telegraph Company. In 1853 he had charge of the laying of ten copper wires—insulated separately with two coverings of gutta percha, then laid longitudinally together and bound with tarred hemp and placed in a wooden trough—in a trench made by the side of the old coach road from London to Manchester, and from Preston to Liverpool. In the June of that year the Gutta Percha Works were partly destroyed by fire, which caused a serious delay in the progress of this work. Early in 1854 the first cable to be laid in the Mediterranean was commenced. Mr. Smith had charge of the electrical department during its manufacture, and assisted Professor Wheatstone with his experiments on the retardation of signals through this cable while coiled at the works of Messrs. Glass, Elliott and Company, East Greenwich. These experiments were made for the purpose of verifying or correcting the results of similar experiments which had been made by Professor Faraday on lengths of the core of this cable at the Gutta Percha Company's works earlier in the same year. Mr. Smith took charge of the electrical department during the laying of this cable between Spezzia and Corsica, Corsica and Sardinia; and in the following year was similarly employed in the manufacture and laying of a cable between Sardinia and Bona. During the manufacture of this cable Dr. Whitehouse made experiments with it to obtain trustworthy data for giving suitable proportions for the core of an Atlantic cable which was then in contemplation. On Mr. Smith's return from this expedition he remained at home as electrician and manager of the wire department at the Gutta Percha Works, and at once commenced to prepare for the manufacture of 2,500 miles of core for a cable which was to be laid from Ireland to Newfoundland.

In 1857 Mr. Smith exhibited at the Polytechnic his electric railway signal, which was favourably noticed in the scientific journals at the time. By his arrangement the signal could be placed at any desired distance from a station, and yet the nature of the signal, whether red, green, or white, would be registered at the station where the man in charge had sole control over the apparatus. Mr. Smith has in his possession models which he made about the same time, illustrating how a train passing through a tunnel, or over any section of a line, would give its own signal on entering, and remove it on leaving the tunnel or section; also how trains running on the same line could communicate with each other, or any desired station on that line.

In 1851, after the manufacture of the single covered copper wire already referred to as having been laid from Dover to Calais, it was thought advisable to apply the gutta percha in two or more thin, instead of one thick covering; and to insure adhesion between these separate coverings coal tar naphtha was employed. But time showed that so strong a solvent of gutta percha was very prejudicial to its durability, and in 1858 Mr. Smith invented an insulating and adhesive compound suitable for application between each covering of the gutta percha, instead of the coal tar naphtha. This compound was soon adopted, and is in general use at the present time.

It had long been a source of complaint that while repairing submarine cables there was great difficulty in insulating the joint, owing to the water entering at the fault and traversing a considerable distance along the strand. To obviate this serious objection to strand conductors, Mr. Smith passed the centre wire of the strand through the compound before mentioned just before the other six wires were laid round it, the result being that not only did six inches of a strand so constructed resist the passage of water at a pressure of 1,000lb. per square inch, but that the compound filled the interstices of the strand, and thus made a more perfect adhesion between the conductor and the first covering of the gutta percha. This has proved of great value, and is now universally adopted.

In endeavouring to arrive at the right solution of the perplexing problem why cables, the electrical condition of which had been all that could be desired during manufacture, shipment, and laying, should develop faults of various resistance at various periods after submersion, Mr. Smith made a series of experiments with artificial faults served with tarred yarns, the same as the cores of cables were served, and submitted to various pressures of water. He found that, owing to the insulating properties of the tar, the faults did not develop themselves until after long submersion, in some instances extending over two years. To obviate this serious defect in the construction of cables, Mr. Smith proposed that tar and other insulating fluids should be abandoned, the serving being tarred only for the purpose of preserving it, and that it should be applied to the core thoroughly saturated with water, then coiled in tanks where it would remain in water. Then, should the core contain an incipient fault still undeveloped, when it passed the lay plate of the wire covering machine the pressure of the iron wires round the serving would force the water into the fault and at once develop it. This is known as the "wet serving" process, and has been adopted in the manufacture of all submarine cables.

In 1864 the works of Messrs. Glass, Elliott and Co., at Greenwich, and the Gutta Percha Company were formed into "The Telegraph Construction and Maintenance Company," Mr. Smith retaining his position at the Gutta Percha Works.

In 1865 the late Sir Richard Glass, the then managing director of the Telegraph Construction and Maintenance Company, requested Mr. Smith to accompany the "Great Eastern," and render assistance, if necessary, in the laying of the cable from Ireland to Newfoundland. It is matter of history that owing to the frequent appearance of faults, caused by the ends of the broken iron wires of the outer covering becoming disturbed and puncturing the gutta percha in the conductor, great difficulties were encountered, and, after laying 1,200 miles, and, while endeavouring to recover a fault, the cable parted. After many fruitless endeavours to recover the cable, the expedition returned to refit, but ultimately it was considered that the year was too far advanced to continue such operations in mid-Atlantic. Mr. Smith considered the electrical system employed on the occasion imperfect, inasmuch as it allowed faults, which were evidently caused on board, to pass miles astern before they were known to exist; he therefore devised an entirely new and original system, which would not only keep a continuous insulation test on

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the whole of the cable, but also allow ship and shore to converse freely through it without interfering with either the insulation or continuity tests. The system met the hearty approval of all the gentlemen requested to examine and report upon it. Mr. Latimer Clark reported: "I have examined the system carefully, and have experimented upon it through upwards of a thousand miles of the Atlantic cable now on board the 'Great Eastern,' and I find it in every way suited for practical use; it allows of the free application of the various tests requisite during submergence of a long submarine cable, and it has the peculiar merit of giving an absolutely continuous test of insulation, and at the same time of enabling the tests for continuity of the conductor and the transmission of intelligence to be carried on uninterruptedly without the necessity for any change in the connections of the apparatus employed either on ship or shore."

We might quote Sir William Thomson and other eminent men, but the space at our disposal will not admit of our doing so. Mr. Smith has given a very interesting account of the system in his paper on "The Working of Long Submarine Cables," which he read before the Society of Telegraph Engineers and of Electricians, 12th February, 1879.

Early in 1866 Mr. Smith was appointed chief electrician to the T. C. and M. Co., and in that capacity was engaged on board the "Great Eastern" during the successful laying of the cable from Ireland to Newfoundland, and the recovery and completion of the cable lost the previous year. Mr. Smith's new system was adopted on that occasion and in the paper just referred to Mr. Smith states, "The whole worked remarkably well." During the fourteen days occupied in laying the cable from Ireland to Newfoundland 164 messages in all were sent and received between ship and shore, containing 6,437 words, or 30,059 letters. Early in the forenoon of each day interesting paragraphs from the morning papers were sent to the ship; these Mr. Smith posted outside the test room, with the heading "The 'Great Eastern' Telegraph." It was pleasing to see the great interest taken in this paper: the sailors, cable hands, firemen, &c., as they came off duty, would wait round the door of the electrical room, anxious to learn the home news before they retired for their well-earned rest.

On the completion of the cables, Mr. Smith applied his system to their working, and before he left the station at Heart's Content, to return home in the "Great Eastern," he had the pleasure of seeing a speed of thirteen words per minute pass through each cable.

Submarine telegraphy has made such rapid strides and has become so familiar to all that only those who remember the days of which we now write can fully appreciate the value of the work that was accomplished by the successful completion of telegraphic communication between England and America.

On the return of the "Great Eastern" the gentlemen who had achieved so much were justly *fêted*. The Liverpool Chamber of Commerce invited them to a banquet, at which the Right Hon. Sir Stafford Northcote, President of the Board of Trade, presided. During the evening the chairman read a letter from Lord Derby, in which he stated that Her Majesty had been pleased to direct that the honour of knighthood should be conferred upon Professor Thomson, Captain Anderson, and Messrs. Glass and Canning. Her Majesty further marked her approval of the public spirit and energy of the two companies by offering the dignity of a baronet of the United Kingdom to Mr. Lampson, deputy chairman of the original company, and to Mr. Gooch, M.P., chairman of the company which finally accomplished the great design. The American Chamber of Commerce, at Liverpool, had four massive gold medals struck, with appropriate designs on either side of each, and at a public banquet given in that city presented one to each of the following gentlemen:—Sir James Anderson, captain of the "Great Eastern;" Sir Samuel Canning, engineer of the expedition; Willoughby Smith, electrician to the expedition; and Cyrus W. Field, as chief of the originators of the enterprise.

Mr. Smith's system having proved so successful with the Atlantic cables, on his return from this expedition he was requested to apply it to the cable, then in bad condition, between Malta and Alexandria. In this work he was also successful, and has given the results of his labours in his paper, already referred to, on "The Working of Long Submarine Cables." In 1868 a cable was laid direct from Malta to Alexandria. Mr. Smith accompanied this expedition as electrician in charge, and employed the same system as that used on the Atlantic cables. On the completion of this line the first test message sent through it was at a speed of twenty-one words per minute.

On Mr. Smith's return to England what is known as the "French" Atlantic cable was commenced, and in the June of 1869 he was again on board the "Great Eastern" in charge of the electrical department. This cable was successfully laid from Brest to St. Pierre, but Mr. Smith returned home broken down in health, and was for three months incapacitated for business.

About this time the use of india rubber in place of gutta percha for insulating the conductors of submarine cables was being strongly advocated on account of its comparatively low specific inductive capacity; but, soon after Mr. Smith's restoration to health, he showed how the specific inductive capacity of gutta percha could be reduced to an equality with, if not below, that of india rubber. He submitted samples of core so manufactured to gentlemen eminently qualified to report upon them, and they reported that the specific inductive capacity of what was termed "Willoughby Smith's gutta percha" was 18 per cent. lower than that of ordinary gutta percha. This was an important discovery, as the amount represented a similar percentage of increased speed in conductors insulated with gutta percha.

This system of manufacture has maintained its ground, and india rubber for submarine cables is now never mentioned.

Mr. Smith has been intimately connected with the Society of Telegraph Engineers and of Electricians from its commencement, and he has communicated the following papers to that society:—"Underground Telegraphs," "The Effect of Light on the Electrical Qualities of Selenium," "The Working of Long Submarine Cables," "A Resumé of the Early Days of Electric Telegraphy," "Volta Electric Induction."

In 1882 he was elected its president, and in January, 1883, delivered his inaugural address, which is published in the society's *Journal*, and we would recommend all who take an interest in electrical science to study this address. The concluding remarks so please us that we cannot refrain from quoting them here:—"In conclusion, I would remark, especially to the younger members of this society, that it has always been my endeavour to follow the advice of an author, whose name I have forgotten, but who wrote, 'I find a frank acknowledgment of one's ignorance is not only the easiest way to get rid of a difficulty, but the likeliest way to obtain information; and therefore I practise it. I think it an honest policy. Those who affect to be thought to know everything often remain long ignorant of many things that others could and would instruct them in if they appeared less conceited.' The tendency of the present day appears to be to sacrifice much to the love of gain. We have an honourable calling; then let our endeavour and ambition be to guard it as such, and in so doing 'learn to labour and to wait' for that reward which is sure to crown the labours of the honest worker."

In June last Mr. Smith gave a lecture at the Royal Institution on "Volta and Magneto-Electric Induction," in which he propounded a new theory, and called in question the correctness of some of the results given by Faraday.

Mr. Smith is still electrician-in-chief to the Telegraph Construction and Maintenance Company, and also manager of their gutta percha works, Wharf-road.

MESSRS. WOODHOUSE AND RAWSON.—We are requested to state that although Messrs. Woodhouse and Rawson have transferred their manufacturing business at Cadley Hall Works, Hammersmith-road, to a limited liability company, this will not interfere in any way with the general business carried on by them at 11, Queen Victoria-street, as electric light contractors and suppliers of electrical goods.

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ON RESISTANCE COILS FOR LARGE CURRENTS.

BY W. H. SNELL.

In the construction of resistance coils for large currents it is sometimes taken for granted that it is advantageous to make use of a metal having a high specific resistance. Hence either German silver or iron is usually employed for the purpose. If the coils are to be used for purposes of measurement German silver is, of course, indispensable on account of its small temperature coefficient. But for merely interposing a graduated resistance in the circuit, or in any case where the current happens to be constant, it may be shown that by employing the metal of lowest specific resistance we effect a very considerable economy in the total weight of metal required for a given resistance, and with proper arrangements also an economy of space. Under certain circumstances these considerations become of primary importance in arranging a set of coils.

The problem (which is, of course, one of elementary character, though I am not aware that it has been previously discussed) considered in this paper, is to obtain the constants of coils of any metal, joined either in series or in multiple arc, which under a given current shall not exceed a given temperature, and at that temperature shall have a given total resistance.

Let C = given current,
t = rise of temperature allowable,
R = required resistance.

Case I.—When the coils are in single series, and are therefore traversed by the whole current C,

Let d = diameter of wire in centimetres.
r = specific resistance (in ohms) of the metal at the total temperature $(T+t)$.
e = the "emissivity" for heat per square centimetre of surface of wire. Following Professor Forbes we may take its value (at a minimum) as $e = 0{\cdot}0002$.

We have then the well-known formula $C^2 = \frac{d^3 t \pi^2 e}{4 \times 0{\cdot}24 \times r}$

Putting $k = \frac{0{\cdot}96}{\pi^2 e}$ $\quad (\log k = 2{\cdot}686941)$,

we may write for the diameter of the wire in centimetres

$$d = r^{\frac{1}{3}} k^{\frac{1}{3}} \left(\frac{C^2}{t}\right)^{\frac{1}{3}} \quad \ldots\ldots \quad (1)$$

If L = length in centimetres of this wire, to give the required resistance R we have $L = \frac{Rd^2}{r}$ $\therefore$ from (1)

$$L = r^{-\frac{1}{3}} k^{\frac{2}{3}} \left(\frac{C^2}{t}\right)^{\frac{2}{3}} R \quad \ldots\ldots \quad (2)$$

If W = weight of this wire in grammes,
g = specific gravity of the metal, we have

$$W = L d^2 \frac{\pi}{4} g; \quad \therefore \text{ from (1) and (2)}$$

$$W = r^{\frac{1}{3}} k^{\frac{4}{3}} \left(\frac{C^2}{t}\right)^{\frac{4}{3}} \frac{\pi}{4} g R \quad \ldots\ldots \quad (3)$$

From these formulæ it appears that for coils having equal resistances at a given temperature, the *diameter* and *weight* is directly and the *length* inversely proportional to the cube root of the specific resistance of the metal at that temperature.

In (1) put $r^{\frac{1}{3}} k^{\frac{1}{3}} = a$,
„ (2) put $r^{-\frac{1}{3}} k^{\frac{2}{3}} = b$,
„ (3) put $r^{\frac{1}{3}} k^{\frac{4}{3}} \frac{\pi}{4} g = c$.

Then (diameter) $$d = a\left(\frac{C^2}{t}\right)^{\frac{1}{3}} \quad \ldots\ldots \quad (4)$$

(length) $$L = b\left(\frac{C^2}{t}\right)^{\frac{2}{3}} R \quad \ldots\ldots \quad (5)$$

(weight) $$W = c\left(\frac{C^2}{t}\right)^{\frac{4}{3}} R \quad \ldots\ldots \quad (6)$$

The values of the constants a, b, and c for copper, iron, and German silver are tabulated below; but the figures given are of value mainly for purposes of comparison, unless in any case the theoretical value of a coincides with some diameter on the wire gauge. Probably the results obtained are all somewhat too high, especially for smaller wires, as no allowance is made for convection or for the cooling influence of terminal masses. Table II., giving the constants for the other metals relatively to copper, is of most value. The specific resistance has been taken for 96 per cent. copper and for a total temperature $(T+t) = 80°C.$ $(= 176°F.)$. For any practical purpose, inasmuch as r appears in the form of its cube root, the value here assumed for r may be taken as constant within practical limits, whatever value be given to t. (In formulæ (4), (5), and (6) it will not, however, be well to assume a value for the term t itself and include it in the constant, because in the two latter it appears under a higher index.)

TABLE I.

	a		b		c	
	cm.	inches.	metres.	ft.	grammes.	lb.
Copper	·1034	·0407	... 47	154	... 343·5	0·76
Iron.....	·1854	·0730	... 26	86	... 552·0	1·22
German silver...	·2198	·0865	... 22	72·5	... 713·5	1·57

Copper being taken as unity, the ratios for the other metals are as follow:—

TABLE II.

	Diameter.	Length.	Weight.
Copper	1	1	1
Iron	1·8	0·56	1·61
German silver ...	2·125	0·47	2·08

Case II.—n coils joined in multiple arc. In this case, in order to obtain the same total resistance R, we must have for each coil a resistance n R. Nevertheless, under the required conditions, and owing to the increase of surface in proportion to mass, the total weight of metal required is less than when $n = 1$.

The current traversing each coil will be $\frac{C}{n}$. We therefore have from (4)

$$d_1 = a\left(\frac{C^2}{n^2 t}\right)^{\frac{1}{3}} = a\left(\frac{C^2}{t}\right)^{\frac{1}{3}} n^{-\frac{2}{3}}$$

$$\therefore d_1 = d\, n^{-\frac{2}{3}} \quad \ldots\ldots\ldots\ldots \quad (7)$$

Let L_1 = total length of the n coils
and l = length of each coil; then from (5)

$$l = b\left(\frac{C^2}{n^2 t}\right)^{\frac{2}{3}} n R = b\left(\frac{C^2}{t}\right)^{\frac{2}{3}} n^{-\frac{1}{3}} R$$

$$l = L n^{-\frac{1}{3}} \quad \ldots\ldots \quad (8)$$

and $$L_1 = n l \quad \therefore L_1 = L n^{\frac{2}{3}} \quad \ldots\ldots \quad (9)$$

Let W_1 = total weight of the coils, then

$$W_1 = L_1 d_1^2 \frac{\pi}{4} g \quad \therefore \text{ from (7) and (9)}$$

$$W_1 = L d^2 \frac{\pi}{4} g\, n^{-\frac{2}{3}}$$

$$\therefore W_1 = W n^{-\frac{2}{3}} \quad \ldots\ldots \quad (10)$$

Therefore from (7) (9) and (10) for any sets consisting of n coils of any metal joined in multiple arc, each set having the same total resistance, and proportioned so as to attain the same temperature under the same current, the diameter and total weight of the wire will be *inversely* proportional to $n^{\frac{2}{3}}$ and the total length will be *directly* proportional to $n^{\frac{2}{3}}$.

The following table gives the values of a, b, and c for copper for the first four values of n, giving results in centimetres, metres, and grammes respectively. The fourth column (b) gives the *total* length for n coils.

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TABLE III.

n	n^2	Diameter. a	Length. b	Weight. c
1	1·00	·1034	47·0	343·5
2	1·59	·0651	74·5	216·5
3	2·08	·0497	98·0	165·0
4	2·52	·0410	118·5	136·5

The *ratios* of *a*, *b*, and *c* for the other metals compared with copper remain, of course, as already given in Table II.

APPARATUS FOR TESTING LIGHTNING CONDUCTORS.

BY C. AND E. FEIN, STUTTGART.

The electrical testing of lightning conductors is at present carried out in a manner more or less complete—generally the latter. As a rule the condition of lightning conductors is considered satisfactory if the needle of a common galvanometer, connected by wire with a battery, causes a deflection.

This examination only shows that the circuit is unbroken, or, if not, it permits of ascertaining the point where the circuit is interrupted; but it does not show the resistance of a lightning conductor. Still, such knowledge is of great importance, as the resistance should not exceed a certain amount. It is true that the efficient state of lightning conductors has been approximately estimated by the extent to which the needle is deflected; but this result is not trustworthy, the degree of deflection not being in direct ratio to the resistance of the circuit, and the elements usually employed not being sufficiently constant.

Another method is often adopted by which the actual resistance may be measured; but it requires many instruments, as well as a voluminous scale of resistances, to be substituted for the lightning conductor, so as to obtain a deflection equal to that of the latter, the resistance required for it being that sought. Apart from the indirectness of this method and the large volume of the whole apparatus, only experienced electrical engineers are able to use it, and the battery elements used must be very constant, for the results are incorrect if the strength of the current varies during the test.

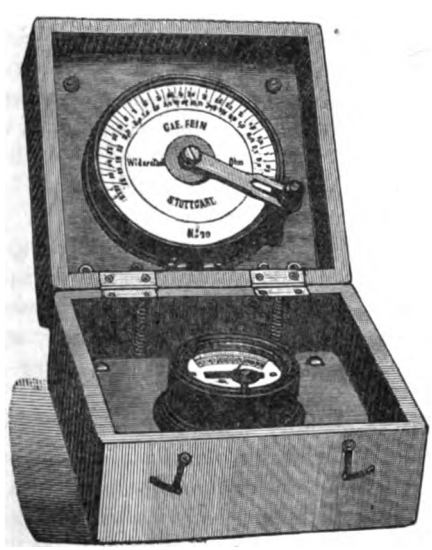


FIG. 1.

To overcome these drawbacks, the above-named firm has constructed apparatus, which permits of measuring the resistances of lightning conductors, in a simple and trustworthy manner, by a combination of the Wheatstone bridge with a sensitive galvanometer. These instruments, with all the accessories necessary for the test, are packed in two convenient cases; and they can be brought into action quickly and easily, so that the tests may be carried out correctly and without loss of time. The use of these instruments is very simple, so that anyone may employ them by attending to the directions.

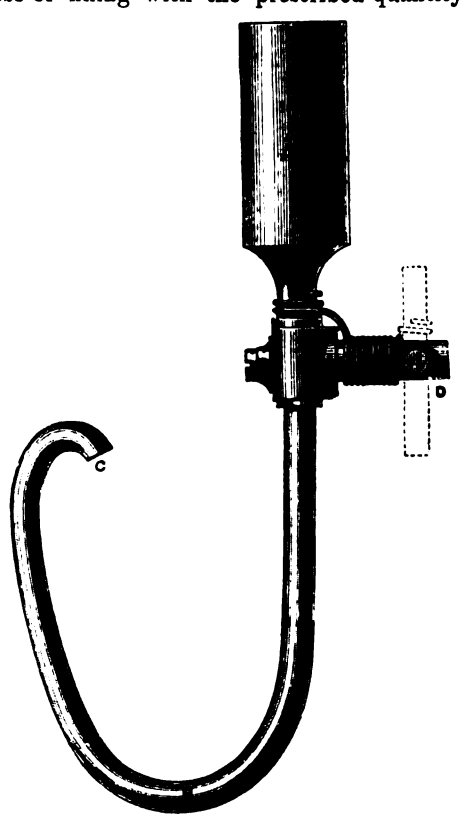
One case (Fig. 1) contains the battery, the leads, two good strong binding screws, a file to remove the coating of oxide from the lightning conductor, and a copper earth plate for testing the earth circuit. The battery cell is of india rubber, containing a bichromate of potash solution in which the zinc rod is immersed. The leads are small cables of fifty copper wires, well insulated and wound on two spools, by which they can be readily rolled up and unrolled. They have a high conductivity, and are very flexible, so that tests may be carried out in difficult situations.

Another case contains the measuring instruments proper, which consist of a correct galvanometer, with an arrangement to stop the hand at any given point, and a Wheatstone bridge with standard resistances, the wire of which is wound round a circular slate tablet, the sliding contact being changeable by a crank. The pitch-circle permits of a direct reading of the resistances between 0 and 25 ohms. This is sufficiently minute for such measures, because the resistance of the above ground circuit of a lightning conductor should not exceed 0·5 ohm, and that of the earth circuit not 20 ohms.

Messrs. Fein have now constructed this apparatus for several years, and guarantee its efficiency, as has been proved by all the tests made with their aid. It must, however, be borne in mind that such tests can only prove the conductibility of lightning conductors, and that it is important for the instruments acting properly that the circuit should also be properly tested.

A NEW FLUID INSULATOR FILLER.

We herewith illustrate a syphon recently designed by Mr. Wittkugel, of the Indo-European Telegraph Department, for the purpose of filling with the prescribed quantity of oil the



patent fluid insulators invented by Messrs. Johnson and Phillips.

A is a cup of the proper dimensions to hold the requisite quanity of oil; B, a tube, so curved as to bring the end C over the interior of the fluid chamber after being placed in position; D, a handle to open a tap, so that the oil may flow from the cup A through the tube B to the insulator. The tap is closed automatically, by means of a spring, upon the handle being released.

This apparatus will greatly facilitate the filling of fluid insulators, and is so extremely simple that a small boy might work it.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

LETTERS AWAIT

H.A.E., H.A., Zeno, Electric Star, Accumulator.

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NOTICE.

We this week give the first of a series of Portraits from steel engravings, which we contemplate issuing from time to time. Every Subscriber should receive a copy with his paper, and any one not receiving the Supplement should communicate direct with the office. The steel engravings are supplementary to the more humble portraits from wood-blocks; but we trust that many eminent electricians will figure in both series.

THE ANGLO-AMERICAN BRUSH COMPANY.

The annual report of the ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION, a full reprint of which will be found in another part of this paper, is a document of considerable public interest at this juncture, besides being, as we should suppose, highly satisfactory to the holders of shares in that company. Its balance-sheet is, we believe, the first of its kind that has shown a leaning to the right side; at all events, of profits derived from actual work done. This very Company, or Corporation, as it prefers to be called, derived, as all the world knows, a large revenue—or perhaps we should rather say acquired large sums of money—from the sale of privileges to subsidiary companies. And so active was the demand for these privileges that the parent concern was enabled not only to do a good deal of its own work for less than nothing, but to figure on the market as a mine of fabulous wealth. Its shares were for a time at a high premium, and when they reached their highest possible the holders realised considerable fortunes by selling out. In this way, no doubt, the electric light "business" was worked at a profit, but in no other sense until now has there been any work or business done on profitable terms.

Last year, however, came the turning point with this as with all the other electric light companies, when it became evident that they must sober down to the humble functions of an industrial corporation, and abandon altogether the higher flights of financial speculation. They reduced their nominal capital, and started the year determined to work for their living. Their balance then was on the wrong side to the tune of sixteen hundred pounds, and they had to face a depressed condition of trade, which got worse rather than better as the year went on. Nevertheless they have passed through the ordeal safe in the possession of a net profit of over £4,000, after paying all standing charges and expenses, including the adverse balance of '83. The report furnishes no details of the character of the business done; but it amounted in the gross to nearly £17,000, a sum which, although ridiculously small compared with the capital invested, is highly encouraging as a beginning, and, all the circumstances considered, is better than might have been expected. No pretence is made of paying a dividend, what remains after reducing cost of goodwill, patents, &c., being carried to next account.

It is proof of the managers' fixed intentions to steadily develop their business that they have not hesitated to spend money on the improvement of their apparatus. To hold their own against competitors they must never relax their vigilance, nor grudge such outlay. But there is every temptation to be parsimonious in these particulars when times are bad; and the management has shown a wise foresight in keeping pace with invention, this being the surest way of laying a solid foundation for a remunerative business in the not far distant future. The new armature of the Brush machine has undoubtedly increased its efficiency, and the improved regulators for the lamps are well worth the money spent upon them. On the other hand, the economy displayed in legal expenses is not less gratifying. Some threatened lawsuits have been averted, and others that were pending have been arranged; "the corporation is now happily not involved in any litigation"—words which both this and every other electric light company would do well to get stereotyped for all future annual reports.

Of course a portion of the report is devoted to remarks on the adverse influence on electric lighting enterprise exerted by the Act of 1882. A good deal more might have been said; for, in truth, the Brush Company's vicissitudes, at all events for nearly three years, are in great measure due to the operation of that Act, the present report being, indeed, the best practical commentary upon it that we have yet seen. Here is a company with an excellent system, an energetic management, a competent staff, and ample capital; yet such have been the hindrances thrown in its way by legislation that its main business has consisted, apparently, of contracts for small installations, nowhere for lighting any district on a large scale. Its powerful influence has been brought to bear on the Board of Trade, and it has co-operated with the Committee which waited upon the President a short time ago. The Company insist, like everybody else, on a radical amendment of the Act, and express themselves sanguine of obtaining what they want in the forthcoming session of Parliament. We trust they may not be disappointed. The satisfactory point about their report is that they have made good progress with business, even outside the reach of the Act, and are evidently preparing themselves for largely increasing it. In this way,

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we think, they are doing the best possible service to the cause by demonstrating the advantages of electric lighting, by showing that it can be worked profitably on ordinary commercial principles, and inferentially that it cannot be undertaken under the restrictions and penalties of the Act which was passed ostensibly to promote it. On the other hand, the comparative smallness of their profits, the largeness of the preliminary expenditure, and the cost of keeping up their appliances to the level of scientific and mechanical discoveries show how hardly the Act in its present shape would have borne upon electric lighting undertakers if they had accepted its conditions. Happily they have not; the public conscience will support them in this, we think; and the public demand for the light will in the long run help them to obtain better terms. Meanwhile their policy is to push private business as energetically as possible, but above all to supply nothing but the very best article procurable. The demand for it will depend chiefly upon the satisfaction it gives to their customers.

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I do not know that there is anything to add to what I have already said on this subject, except to explain my views on the measurement of the resistance of the body by means of alternating currents, and my "sweeping condemnation" of that process. Dr. Stone, page 223, says he has not heard before of its accuracy being questioned; but I questioned and condemned it in the first edition of my "Electricity," not by name possibly but in principle, as used for measuring the resistance of water, &c. But Dr. Stone, by his remark that my "suggestion that a wire resistance balanced against the body may act as a short-circuiting shunt rather than a fair derived circuit" shows that he has not perceived the real meaning of my objection, and though he says that I have given no proof, the Doctor has kindly supplied it for me. As a consequence I may be able to save him trouble and disappointment in the results of his proposed plan. I may add that his plan is not quite new; I have used it myself for measuring liquid resistance while getting rid of "polarisation." I described one form of the apparatus in my "Electricity," and it will be found p. 299 of the second edition or 194 of the first. To effect Dr. Stone's purpose, which is obviously to compensate the electrolytic polarisation of the body, he must use the liquid cell in one branch only; as he proposes to operate he will have merely added a liquid cell in each of the two branches to the body and the resistance instrument. He should insert in the branch which includes that measure an electrolytic cell whose electrodes should be nearly the same size as the conductors attached to the body, and its reactions nearly the same; then, having ascertained the resistance of this voltameter, he would add that to the other resistance measured. But even then he can never get a true result with intermittent or alternating currents. To explain why this process is useless (notwithstanding the names of Wheatstone and Kohlrausch) it is necessary to look into principles.

Now, what is *resistance?* The resistance of Ohm's formula is merely the reciprocal of the conducting capacity of the circuit, or a relation of *time* to other conditions which govern current. Its fundamental characteristic is that it is *invariable for all rates of current*, the same when measured under varying electromotive forces.

Well, Dr. Stone tells us that he gets variable measures when he uses 40 volts or 6 volts. So will any one who uses alternating currents to measure circuits in which there is either static or magnetic capacity, or electrolytic polarisation; because in all these cases we have either an extra E.M.F. or work in some form to deal with, as well as the normal resistance of the circuit. The result may be either a real increase of apparent resistance, or an apparent diminution of real resistance. It is this latter effect to which I referred (p. 203), though in describing the cause or action as that of a "shunt circuit," I am not quite sure that I used a term quite justifiable.

To make my meaning clear, let us conceive the branches of a bridge in one of which we place a condenser instead of an electrolyte or a human body; we then balance this in the opposite branch by a rheostat, giving a through wire circuit. We can thus obtain a balance either with continuous or alternating currents, but the measured *resistance* shown will be different, and will vary under the alternating current both with the E.M.F. and with the rate of intermittence. It is evident that we are balancing different things; in the wire circuit actual current passes in all cases, in the condenser it does not pass with the alternating current, but a succession of reverse charges on the plates represents a fictitious current. Exactly the same occurs when we balance an electrolyte or a human body against a measured wire circuit, and the apparent resistance thus obtained is a delusion. The proof of this is the fact noted by Dr. Stone that it varies with the E.M.F. used, and he would find it vary also with the same E.M.F. if he employed different rates of reversal.

This brings me to the question of *capacity* in two forms. Mr. Blakesley (p. 203) and I had obviously the same idea in our minds when he spoke of the electrostatic capacity of the body, and I compared the action to that across a set of condenser leaves, owing to the different conductivities of the liquids and the membranes and cell walls. Hence at every change or reversal of E.M.F. we must have corresponding "changes," as in a cable, with the corresponding mechanical attractions and nervous contractions. But besides this I use the term "conducting capacity," which Dr. Stone says he does not quite understand. Probably he means the same thing by "conductivity," but I prefer to leave that term to its common use as related to the specific properties of substances, and to express the conductivity of any defined circuit as its "conducting capacity," measured by the current it permits to pass under unit E.M.F. The reciprocal of this is the so-called "resistance," while the reciprocal of any measured R gives us the conducting capacity of the circuit; the term is, in fact, the dynamic analogue of the static capacity of a condenser. Now this *conducting capacity* of a circuit, measurable by the actual currents transmitted, is, I contend, the only true measure of the practical resistance, and includes any existent E.M.F. or work in any actual circuit.

I quite understand Dr. Stone's desire to get at the inner resistance of the body and separate that of the skin, and can sympathise with it as a matter of pure scientific investigation. I am also inclined to believe that the pure skin, and also the inner membranes and cell walls, are as nearly insulators as paper is, and that their actual conductivity is simply that of the liquids they contain, as in the case of porous jars; but from the practical point of view, and as to this question of danger, it seems to me not only useless but wrong to eliminate the skin resistance, simply because it is the usual practice of people to wear their skins, and to keep them in an ordinarily dry condition. No doubt a cut or abrasion greatly reduces the resistance, and might occasionally come into play in an accidental contact.

I have not read the papers of Dr. Stone to which he refers, but if he will accept a suggestion from me, I think I can put him in the way to do what he wishes. Let him use flat electrodes cased in cloth, so as to prevent actual contact with the skin, and put them in pans of salt water so that the hand or foot can be placed upon them; or the ordinary tubular conductors cased in thick cloth can be used. Then have a similar pair, placed in a pan of the liquid, and made part of the branch of the bridge which contains the resistance measure, using two equal resistances in the other branches, so as to have equal currents passing both pair of electrodes, and therefore equal polarisation effects. The resistance of this cell (which replaces the voltameter I first suggested above) can now be ignored, because it is closely equal to that of the connections to the body, and the observed resistance will be that of the

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body itself free from secondary reactions. Even then I should look for different measures with constant and with alternating currents. But the measurement of this difference would in itself be interesting and valuable, for it would indicate something of the storage capacity of the body, as distinguished from its transmitting capacity, and so open a road to knowledge of the reasons why the alternating current has the greatest effect. On this head I may as well indicate another anomaly in the applications of Ohm's formulæ in these cases. If we found that the resistance as measured with alternating current is less than with the continuous, it would not follow that the current or the energy passed into the body is greater for an equal E.M.F. Two reasons would be against this :— 1. An alternating E.M.F. would not be active for the whole time. 2. The lower resistance would not be a real fact, but an erroneous deduction.—Yours, &c.,

JOHN T. SPRAGUE.

P.S.—It appears that I somewhat misunderstood Dr. Stone's intention as to his proposed liquid resistance. I see that he means to use it simply as one branch of the bridge, and as the total resistance balancing the man. At first reading I thought he meant to use the shifting electrode as the movable contact of a bridge. This, of course, modifies part of what I have said above. But still it is doubtful if the desired result will be attained, as the liquid resistance differs from a wire rheostat only at the electrodes, and therefore these ought to correspond completely with the conductors to the body. I have often employed liquid resistances just like the proposed one, but have found that every motion of the electrode produces a great disturbance in the balance. However, if Dr. Stone wishes to try it, I will describe the apparatus I have found most suitable.

Let two glass tubes be mounted vertically and close together on a stand, their upper ends being considerably enlarged, so as to contain a cylindrical electrode of large surface ; a syphon tube reaching to the bottom connects the liquids in the tubes, so that the current has to traverse the syphon, which is a fixed resistance, and the outer tubes, the resistance of which is variable by raising the syphon which is suspended from a counterpoise in front of a scale upon which the resistance in ohms corresponding is marked. I have also used two horizontal troughs side by side, built of strips of glass cemented together, and united by a movable syphon. The vertical plan enables the liquids to be covered with a layer of paraffin oil to prevent evaporation and the nuisance of creeping. I have usually employed sulphate of copper, reversing the current occasionally; but for the intended use in which the polarisation effect is desired, dilute salt water would be preferable. Such a liquid resistance measure is useful when an invariable resistance is required, because by combining with it a due proportion of metallic resistance we can compensate for variation of temperature.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I am sorry to find that Dr. Stone considered the tone of my letter discourteous. I am unconscious of any intention to be so ; nor can I, on a careful perusal of my letter, find any expression that I should so interpret if applied to myself.

At the same time, I at once and freely tender my apology for any inadvertence that may have escaped me.

I certainly adhere to my opinion that it is a misfortune that more use was not made of the accident at "The Healtheries," and I would point to the fact that while Dr. Stone is continually asking for facts—even in the letter before me he hopes to obtain authentic *post mortem* records in a particular case—after six months the best that he can tell us of an accident that happened in the very building where he had been lecturing, and the subject of which was taken to a London hospital, is that he *believes* the *post mortem* will be published, urgent and repeated applications for information having meanwhile been ignored.

With regard to my use of the words "may" and "may not," I beg to say that I merely put forward ideas that occurred to me, in the hope that Dr. Stone and others who have a knowledge of the subject would take them up. I have studied the subject for many years, as carefully as time, opportunity, and my necessarily very imperfect knowledge of physiology would allow ; and I have naturally a deep interest in the endeavour to get over the difficulty of using high tension currents, seeing how great the advantages are for the distribution of light and power by means of electricity.

With regard to the question of the resistance of the human body *per se*, I maintain with all due deference to Dr. Stone, and without the slightest intention of discourtesy towards him, that it must be an immeasurable quantity, in the sense that no such thing as its absolute resistance can exist. He himself has shown that the measured resistance depends upon the size, nature, and condition of the electrodes.

On the other hand, a few measurements taken from hand to hand or from hand to feet, one hand having a cut or sore place, and in the case of the measurement from hand to feet the earth forming part of the circuit, would be of great value.

An amusing case came under my own notice which confirms, if confirmation is wanted, Dr. Stone's experience with the spark from his induction coil.

A workman was required to test a faulty battery. He had no galvanometer, and being on the top of one of the Welsh hills, he could not obtain one. He had, however, a sore thumb. He applied the thumb to each cell in succession, pronouncing those cells bad which failed to make him "jump." A subsequent test with a galvanometer confirmed his improvised bad thumb test. The old test of the tongue will naturally occur to everyone.

There is another important matter I wish to refer to. I understand Dr. Stone to hold that the resistance of the body, or any part of it *per se*, varies inversely with the E.M.F. of the testing current.

I have not the slightest wish to impugn Dr. Stone's measurements, upon which he appears to have spent a great deal of his valuable time and also large sums in procuring the most reliable instruments ; but, as I believe I am correct in stating that we have no other instance of a body changing its electrical resistance, unless it had previously been subjected to some other physical change, I would ask, have we any good reason for supposing that the human body is an exception to this rule, and if not, should not the cause of the change be sought ?

I have already suggested in another place that possibly what is measured as apparent resistance is really in part, as in other cases, an opposing E.M.F.

Mr. Sprague and Mr. Blakesley have each given other explanations which are of great interest, and will, I trust, be followed up. The source of the opposing E.M.F. I allude to may be the resultant products of electrolysis, and I have also suggested that it is due to the inductive action upon each other of the fluid conductors, which are each moving at a high speed in the magnetic field which the current in each creates around itself. The fact that the alternating current gives the lowest measured result appears to me to be a confirmation of this, inasmuch as it is well known that alternating currents from their nature create but feeble magnetic fields in comparison with continuous currents. Dr. Stone rather ridiculed my suggestion at the Healtheries, on the ground that he had laid his head between the poles of a powerful permanent magnet, capable of rotating a beam of light through several degrees, but it was unable to rotate him one degree.

Singularly enough, a partial confirmation of my views comes from abroad. I have not the copy of the *Journal of Science* by me in which it is referred to ; but I think it is a German physician who experimented with two similar incubators. One batch of eggs were set in the usual way, but in the other the eggs were exposed to the influence of permanent magnents placed in their neighbourhood. While a fair number of the eggs not exposed to the influence of the magnets produced strong healthy chickens, only a very few of those that were so exposed came to maturity, and of those the whole were irregular in some way or other, one paralysed, and so on. Evidently something had been going on within the eggs, and I suggest that very minute electric currents were generated, which prejudicially affected the embryo.

In looking through the *Journal* of the Society of Telegraph

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Engineers, I notice two very important cases bearing upon the points under discussion.

One is the report of Mr. James Graves of the storm which passed over Valentia in July, 1878, in which several animals were killed, and a cottage wrecked, and in particular three cows were *so burnt that their flesh was quite black*, and the smell so offensive that the farmer could not even remove their hides.

The other is the case mentioned by Professor Adams, of the accident which happened to the engineer at the South Foreland. Evidently in this case the shock was produced by the *extra* current on breaking circuit, and though sufficiently severe to knock the man down, was of so short duration that he received no permanent injury. Comparing this case with that of the stoker on board the Czar's yacht, who, if the reports were correct, only received the E.M.F.. of one Jablochkoff candle, yet was killed, appears to me full of instruction.

I think that here at least we are quite in our infancy, and I repeat that our best thanks are due to Dr. Stone and others who have taken the matter up. If by their researches they can show us how to use high tension currents without danger, they will have conferred a great boon upon society, and will materially aid the advance of practical electrical work.—Yours, &c.,

SYDNEY F. WALKER.

DYNAMO CONSTRUCTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I presume that Mr. Pardoe* is the correspondent who previously signed himself "Volt-Ampere," and I am glad to find that my communication in your issue of the 17th inst. was of service to him. But the question now asked, "What E.M.F. will be generated by A at a given speed and with a given number of turns at a given *velocity?*" is scarcely intelligible. The total E.M.F. of any dynamo, self-exciting or otherwise, may be expressed by $E = K\,\omega\,\frac{W}{a}\,V$ where

E = E.M.F.
V = velocity.
W = weight of copper on armature in pounds.
a = sectional area of wire on armature in square mils.
ω = magnetic field in ampere turns.
K = a constant.
Also let L = length of wire on armature with the winding for E.
L_1 = length with winding for E_1.
C = current in amperes, with winding for E.
C_1 = current in amperes, with winding for E_1.
γ = number of turns on magnets.

Now, although it is not possible to know with any certainty what E may actually turn out to be in the first machine from such a condensed equation as the above, still it may be used with great advantage in practice. For suppose E_1 to be required from the same sized dynamo, then

$$E_1 = K\,\omega\,\frac{W}{a}V.$$

Divide the first equation by the second

$$\frac{E}{E_1} = \frac{a_1}{a} \text{ whence } E_1 = \frac{Ea}{a_1}$$

$$\text{But } a = \frac{d^2\pi}{4} \quad \therefore E_1 = \frac{Ed^2}{d_1^2} \quad \text{and} \quad d_1 = d\sqrt{\frac{E}{E_1}} \quad . \quad . \quad . \quad .$$

W lbs of wire, d mils in diameter, must then be wound on the armature.

We now come to the magnetic field, which is expressed in "ampere turns." The latter term may be defined as the product of the two factors, amperes and turns or convolutions around the iron cores. Whence $V = \frac{\omega}{C_1}$. The output of the machine in volt-amperes will be identical with the two windings, or $EC = E_1C_1$; whence $C_1 = \frac{EC}{E_1}$. Substitute for C_1 and we have $V = \frac{\omega E_1}{EC}$.

The diameter of this wire must, of course, be proportioned to carry the current C_1, and should be such that $d = 32\sqrt{C_1}$, as stated in my previous letter. I fear that Mr. Pardoe does not fully grasp the complex nature of dynamo machines, or he would know that it would require a far greater space than I dare trespass upon to set down my comprehensive formulæ, still more to attempt to explain them.

One caution would, perhaps, not be out of place. Do not try to make very small dynamos, for they will not work, the output of a dynamo being as the third or fourth power of its linear dimensions in practice; so that comparing a small machine with one, say, twice its linear dimensions, the "activity" or output would be, perhaps, only $\frac{1}{12}$ of that of the larger one, and so on until after a certain point it is not even possible to get sufficient work out of a machine to excite its own magnets.

In conclusion, Professor Thompson's "Dynamo Electric Machinery" is published by Messrs. Spon, and its cost is, I believe, about 12s,—Yours, &c.,

G. C. FRICKER.

7, Charlwood-road, Putney, January 27, 1885.

[* Mr. Pardoe and "Volt-Ampere" are not one and the same. A very large number of readers are interested in this information.—ED. *E.*]

ELECTRO MAGNETS AND DYNAMO MACHINES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Two or three letters which have appeared in your columns have induced me to draw attention to the utter dearth of practical information regarding dynamo construction in any of the books which profess to deal with the subject, and the apparent ignorance on practical points of gentlemen who pass for great authorities in matters electrical. I would suggest that if your columns were opened for the discussion of the question, their value to a great many readers would be very much enhanced.

Now, sir, I am a practical mechanical engineer, and having had considerable experience in fitting up and running electric light machinery, I started a short time ago to make my own machines. I could get no assistance from the sources above referred to, and as I am a "cut above" copying, I can assure you that before I got my first *successful* machine completed the expenditure of money and time was something alarming, for every "wrinkle" obtained, or improvement effected, was the result of actual and costly experiment. Now, this is not as it should be, and I am willing to do my little best to assist in throwing more light on this important matter. As I am not an eminent electrician I cannot give much direct information, but I will undertake to be prolific in questions, the answers to which, if given *fully* and *plainly*, would be of much value. Here is a case to begin with:—

I am about to construct the armature of a dynamo, Gramme type, of which

E is the E.M.F. wanted.
D diameter of armature.
N number of turns of wire.
R resistance between brushes.
V revolutions per minute.
d distance between field magnet face and armature core.

These quantities are known, and I want to find S = cross section of soft iron armature core. Of course the more iron in armature the greater the E.M.F., provided the field magnets are sufficiently powerful to induce sufficient saturation of armature core. Now the questions I would first ask are—

1st. What is the best amount of magnetism to induce in an armature core, having due regard to heating, sparking, and other dangers, and how can that quantity be expressed in magnetic units—in fact, how is S obtained?

2nd. Having decided on this, what power must the field magnets have, and what must be the relative mass of field magnet pole, to armature core, to magnet legs, and to yoke piece? Supposing in the first case that the machine is to be

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series wound, and therefore the magnets may be highly saturated, what is the best section for field magnet legs, the best relative length, and what "ampere turns" are required to give the necessary saturation?

Now, I have an experimental armature core or cylinder just making up. The diameter (D) is 8in., the length is 10½in., the thickness is 1¼in., and the cross section (S) is therefore 13·125 sq. in. The distance (*d*) between field magnet face and armature is ⅛in (⅜in. for wire, and ⅛in. clearance); *i.e.*, the field magnets will be bored 9in. Perhaps some of your readers can give me the best form and dimensions of suitable magnets —wrought iron or cast iron—and give the formulæ for obtaining the dimensions.—Yours, &c., MECHANIC.

[We have the first of a series of articles on "Dyuamo Construction" in type, and no doubt all questions by correspondents will receive the careful attention of the author.—Ed. *E.*]

HEATING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In an article on "Railway Carriages Warmed by Electricity," published by your esteemed journal of 27th November last, you attribute all the merit of that invention to M. de Courcelle. Allow me to remark, in connection with the subject, that this is incorrect, inasmuch as some time ago I patented a similar arrangement.

In my system of heating trains by electricity, the electric current traverses the spiral metallic conductors. The foot-warmers are previously filled with a substance possessing great latent heat of fusion, such as crystallised acetate of soda or hyposulphite of soda, and are dipped in boiling water before starting.

The current has then only to maintain the initial temperature of the foot-warmers; and this task is singularly facilitated by the solidification of the acetate of soda, which, as is well known, gives out a great amount of heat. In this way the number of *calories* to be produced by the electrical machine, and consequently the mechanical energy which it absorbs, are less considerable.

In the hope that you will do me the favour to publish these few lines in *The Electrician*, accept, &c.—Yours, &c.,

D. THOMMASI.

Paris, 23rd January, 1885.

INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I don't know whether it is that my knowledge of English is deficient or that "Carbon" (in your last number) has put his query in a very involved form. If he is simply seeking information as to the comparative duration of incandescent lamps run *over* and *below* their "normal" candle-power, I beg to offer him the following average of a very extended series of tests made in the Edison Manufactory, Ivry, near Paris. The lamps were Edison's 16-candles, 100 volts:—

At 100 volts	average	life	of	lamps	was	1,000 hours.
,, 99	,,	,,	,,	,,	1,277	,,
,, 98	,,	,,	,,	,,	1,645	,,
,, 97	,,	,,	,,	,,	2,135	,,
,, 96	,,	,,	,,	,,	2,751	,,
,, 95	,,	,,	,,	,,	3,595	,,

On the other hand, running the lamps at an increased power, we obtained the following results:—

At 100 volts	average	life	of	lamps	was	1,000 hours.
,, 101	,,	,,	,,	,,	785	,,
,, 102	,,	,,	,,	,,	601	,,
,, 103	,,	,,	,,	,,	477	,,
,, 104	,,	,,	,,	,,	375	,,
,, 105	,,	,,	,,	,,	284	,,

Other than Edison's lamps, of which we tested considerable numbers, gave almost identical results.—Yours, &c.,

G. FOUSSAT.

8, Bernard-street, W.C., London, 29th January, 1885.

SMALL MOTIVE POWER FOR ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am afraid that I am very obtuse. For the life of me I cannot master the particulars of the small installation as described by Mr. H. Davy in last week's *Electrician*. His motor house is 9 by 6; not too big I suppose, but just big enough. What is the motor—steam, hot air, gas, or what? Again, does he place the Phœnix on the coke or the hopper? If so, why so? I notice he burns a lot of coke. Why coke? Again, he has a heating coil in his house, heated, I presume, by the combination of coke, electricity, and hot water conveyed through a ¼in. lead gas tube (not too thin, but just thin enough). This last arrangement is beyond my comprehension. I always thought that lead gas pipes (compo they call them in the trade) were very thin; and what a novel idea to carry them along the cornice. Suppose they burst. I have my house heated by hot-water coils, but the pipes from my boiler are 1¼ diameter bore welded steam tube, not lead gas tube, and put in proper recesses in the walls and cased over. Now, I want to know, Mr. Editor, if my saddle boiler would drive a Phœnix machine and light up my house? If not, why not?—Yours, &c., PHŒNIX.

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

Professor Tyndall gave his second lecture on the 30th ult. Following up his previous lecture by recapitulating some of the principles which he had therein enunciated, and reminding his audience that the earlier electricians divided bodies into electrics and non-electrics, he proceeded to say that the real distinction between these bodies was not that one body was capable of being electrically excited and the other not, but that one class were insulators and the other conductors. He then gave some practical demonstrations in order to exhibit the difference between positive and negative electricity, asking his hearers to bear in mind what he had said previously, that when two electricities were mingled together in equal quantities the one neutralised the other. He showed this, first, by means of a small paper wheel, making it run after the glass rod in virtue of the attraction of the positive electricity in the latter on the negative in the former; and the converse. He afterwards repeated on his own person an experiment which he had made in the same room when he had the pleasure of lecturing on this subject some years before. Taking his stand on an insulated stool, the lecturer passed an ordinary ebonite comb through his hair ten times, discharging the comb each time by rapidly passing it through a spirit-flame, with the result that by keeping his hand at the distance of nearly a foot from a strip of lath made to revolve on a pivot, he was able to move that at pleasure round and round, just as if he had held a powerful magnet in his hand. In a like manner he exhibited the law of repulsion. He then passed on to another part of the same interesting subject, namely, to prove how electricity diffuses itself over the surface of a conductor. For this purpose he produced a metallic sphere, to which he communicated by means of the glass rod a certain amount of electricity. Taking to the electroscope, by means of a carrier, a certain amount of electricity, the same divergence of the gold leaf was observable when the sphere was touched on any side. In further proof of this principle of electric diffusion, he experimented with an electrified cone, when a remarkable change became apparent. The divergence of the leaf when he touched the extremities and sides of the cone differed very considerably; in the one case being small, and in the other large, owing, as he explained, to the tendency of the electricity to become intensified at a point which was the case at the tapering end of the cone. The next subject he drew attention to was that of hollow conductors, and for the purpose of showing that the electricity was diffused only on the outside of them, he said he wished to make use of the plainest article he could find, viz., a common teapot. Taking an electrified ball he dropped it into the teapot without letting it come into contact with the edges of the vessel, and the subsequent tests showed that the electricity was to be found only on the outer surface of the teapot, with a tendency to intensity on the spout, as shown in the previous illustration. Coming to the consideration of the influence of points, he was understood to say that Dr. Reiss, of Berlin, determined the sharpness of any given point by the density of the electricity collected on it. The lecturer then gave a very

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beautiful and cleverly-executed demonstration of the use of the lightning conductor and the laws which govern it. Taking what appeared to be a brass or copper tube several feet in length, with a curvature at one end from which were suspended a number of strips of paper each about four feet in length and half an inch in breadth, he communicated the electric current to the other end of the tube by the usual process, and a remarkable effect was produced. The strips of paper, which before were in a state of quiescence, immediately seemed to take life, and spread themselves out until they resembled a cone in shape, or, perhaps, to give a more faithful description, a half-opened umbrella, exemplifying a cloud charged with diffuse electricity. Taking an ordinary sewing needle as his point, he held it under the outspread paper ribbons, which instantly began to converge with a movement similar to that which is manifested by a sensitive plant when it is touched until they were in their original position. Professor Tyndall then observed that clouds were neutralised on the same principle by the discharge of electricity from the points of conductors. At this stage of the lecture a lightning conductor of the ordinary type—that is to say, one possessing several points—was exhibited, and it is worthy of note that the learned professor said that in the case of the experiment he had just finished he had found that a single needle point was equally effective as half a dozen. At the same time, if a cloud came overhead there was no doubt that there would be an electrical discharge from all the points of a conductor, so that it might be desirable to have a cluster of them together. In this connection he said that he was reminded of a custom that prevailed all over the country which was sometimes fraught with disastrous consequences. He had been talking a few days previously to a builder, who told him of certain churches that he had protected from lightning by conductors. This builder, it appeared, was in the habit of raising the conductors above the church spires and sticking the other end of them into the ground only a few inches, in the belief that this precaution was sufficient to secure the churches against injury. Now a few years ago, when he (the speaker) had the honour of being connected with the Board of Trade, a question was referred to him regarding a lighthouse on the coast of Ireland. It was of the kind known as rock lighthouses, and a flash of lightning came down upon it, with the result that it sustained serious damage. An engineer was immediately sent to report upon the nature of the accident. It was obvious from what the engineer said that he was perfectly honest and sincere, though he did not know where to look for the cause of the disaster. But he (the lecturer) followed the description given by the engineer, and found that the lightning conductor ended in a stone, which had been pierced to the depth of six inches. It was perfectly clear that that was insufficient to carry away the lightning, and hence the damage. In such cases the conductors ought to be connected with the sea by a good conductor, ending in a plate of large surface. A model lighthouse was here exhibited, showing a process by which such a contingency might always be obviated, by having a large plate at the base, which would carry off the lightning into the water. Another experiment made in connection with the action of points, and which, he said, if it could be used, would be more useful still, was that of placing a flame under the paper strips, which caused them to converge even more quickly. Before concluding this part of his subject—namely, the action of points, the lecturer gave an illustration of electric wind issuing from the point of a needle. Having taken a small vessel of some kind, into which he poured a quantity of water, he sprinkled a little dry powder on the surface of the water, and projected powder and water upon a screen. Immediately the particles of powder were exposed to the action of the needle they were put into a state of violent commotion, being driven into streams and vortices. Before concluding his lecture, Professor Tyndall gave a few experiments illustrating the principles of the electrophorus. Throughout, it is needless to say, the experiments were watched with the closest attention, and frequently evoked great applause.

EVOLUTION OF THE ELECTRIC RAILWAY: Its Commercial and Scientific Aspect.*

BY DR. W. ADAMS, MEMBER OF THE ENGINEERS' CLUB OF ST. LOUIS.

(CONCLUDED FROM PAGE 228.)

We come now to a practical application of these data.

Suppose we wish to determine whether it will pay to operate a street railway by electricity: Knowing the horse-power which the motor must develop in order to move each car or train over the given maximum grades at a given speed, and knowing the greatest current the conductor we provide can carry without losing more than the prescribed amount, it remains to calculate the electromotive force which the motor must develop.

Supposing the electrical efficiency of the motor to be eighty-five per cent., then $H = \frac{Ie}{746} \times \frac{85}{100}$, because the counter E.M.F. (e) generated by the motor multiplied by the current traversing it measures the *electrical* work it performs. Then $e = \frac{H \times 746}{I} \times \frac{100}{85}$.

In order to find the E.M.F. of the generator (E):

$$\frac{E}{e} = \frac{W}{w} = \frac{I\,e + I^2\,R}{I\,e} = 1 + \frac{IR}{e}\,;\quad E = e + I\,R.$$

Upon these and the preceding expressions are based the following estimates as to the comparative cost of operating a street railway by horse-power, electricity and cable:

COST OF OPERATING ELECTRIC SYSTEM.

44 Cars. *Speed*, 6 *Miles.* *Length*, 5 68-100in.

22 cars acting as locomotives, each one having an additional car attached, and being provided with 8 horse-power.

22 cars, 8 horse-power, multiplied by 2, on the supposition that we get but 50 per cent. return instead of 70, as is possible, = 352 = total horse-power consumed when all the cars are running and consuming full 8 horse-power, a condition which never exhibits—even at such times when the road is working at maximum capacity.

Average power consumed during the running hours ...	200 h.-p.
Pounds of coal consumed, five horse-power per hour...	2½
Total amount of coal consumed per hour.....	500lb.
Working hours per day	20 hours.
Pounds of coal consumed per day	10,000lb.
Cost of coal per 1,000lb., $1.00.	

	Dollars.
First Item.	
10,000lb. of coal at $1.00, $10.00 = cost of coal per day.	
Cost of coal per year	3,650
One engineer at.....per day	5.00
One assistant engineer at .....per day	2.50
One electrical engineer at.....per day	5.00
One assistant electrical engineer at .....per day	2.50
Two stokers at $2.50.....per day	5.00
Second Item—	
Total cost of labour at station per day	20.00
Yearly cost of labour at station	7,300
Third Item—	
Yearly oil and "waste"	500.00
Fourth Item—	
One conductor to every two cars at	2.00
One driver ,, ,, ,, ...	2.00
Cost of labour on each train.....	4.00
No. of trains	22
Total cost of labour on cars per day	88.00
Total yearly cost of labour upon cars.....	32,120.00
Three steam engines of 208 horse-power each	7,500.00
Fittings for same	1,500.00
Two Babcock and Wilcox boilers of 460 horse-power	8,500.00
One Babcock and Wilcox boiler of 146 horse-power capacity	4,070.00
Fittings for boilers.....	1,000.00
Extras	1,000.00
Total net	23,570.00

Four electric circuits of 2¾ miles each, having conductors with electrical capacity of 500 amperes and having a resistance of but one-fifth of the entire line, where each generator and each motor has a resistance of 10 ohms, and of which there are 11, arranged in multiple circuit, equal a copper bar of half an inch in area, costing, at 30 cents per pound:

Cost of copper conductor per mile.....	2,890.60
No. of miles	11
	31,790.00
Cost of conduit and tramway per mile of double track	40,000.00
	2¾
	110,000.00
Electro-motor fittings to 22 cars at $1,000 each	22,000.00
22 electric generator motors at $2,000	44,000.00
4 surplus generators.....	8,000.00
Total cost of generators	52,000.00
Wear and tear on item of motors at 8 per cent.	1,320·00
Wear and tear on generators at 4 per cent.....	2,000.00
Wear and tear on engines and boilers	3,000.00
Wear and tear on cars, conduit and tramway	11,000,00
	17,320.00

* Paper read before the Society of Civil Engineers, America.

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Total Yearly Wear and Tear.

Wear and tear of conductor	Nothing.
44 cars	50,000.00

Yearly Running Expenses.

Fuel	3,650.00
Station labour	7,300,00
Waste and oil	500.00
Labour on cars	32,120.00
Wear and tear as itemised	17,320.00
Total	60,890.00
Yearly interest on capital invested	17,361.60
Yearly expenses, including interest	78,251.60

Capital Invested.

Motors	22,000.00	
Generators	52,000.00	
Engines and boilers	23,570.00	
Electric conductors (copper)	31,790.00	
Conduit and tramway	110,000.00	
Forty-four cars	50,000.00	
Total	289,360.00	
Interest at 6 per cent.	17,361.60	
Present yearly earnings of road upon which this estimate is based		177,000.00
Above estimates suppose the work done to be doubled, and, consequently, the income doubled, making		354,000.00

Estimated from data furnished by a railway company—Present cost of operation with horses—Details of estimate.

	Dollars.
22 cars, earning capacity	177,000.00
Capital invested	225,000.00
Interest at 6 per cent.	13,500.00
Wear and tear at 10 per cent. on invested capital, less cost of horses, the wear and tear of which is included in item of $11,710.20; allowing $25,000 to be deducted from the $225,000 as the cost of horses, leaves as invested capital to reckon 10 per cent. wear and tear upon	200,000.00
Interest at 10 per cent.	20,000.00
Feed	31,689.60
Running expenses of stables and contents	11,710.20
Stable expenses	2,185.00
Blacksmithing	2,356.20
Total	47,941.00
One conductor on each car at $2.00, and one driver at $1.50 22 cars, cost of labour on cars per day	77.00
Yearly cost of labour on cars	27,874.00
Result:	
Interest at 6 per cent.	13,500.00
Wear and tear on $200,000 at 10 per cent.	20,000.00
Total cost of propelling power	47,941.20
Yearly cost of labour on cars	27,874.00
Total yearly running expenses	109,315.20
Will average about	115,000.00

COST OF OPERATING CABLE SYSTEM.

The amount of coal consumed on the Clay-street Railroad is 3,600lb. per day of 17 hours, costing $8 per ton.

Cost of Cable Road Construction.	Dollars.
Will average per mile of double track	200,000
3 miles	600,000
2 horizontal engines, 14in. by 30in., set up	5,800
2 boilers, 52in. by 16ft., set up	4,500
Tank, pump, and heater	1,500
Compensating arrangement at end of line	1,800
Driving machinery, pulley, &c.	6,500
22 cars at $1,000	22,000
22 dummies fitted with grips at $900	19,800
Engineering sundries, at 10 per cent., in round numbers	25,000
Total cost of three miles complete	686,900
Interest at 6 per cent.	41,214

Cost of Operation.

Maintaining cable per year		15,000
Oil and waste		500
Maintaining conduit, tramway and cable bearing sheaves, 10 per cent. on $600,000		60,000
Interest on capital invested, at 6 per cent.		41,214
In round numbers, 600 tons of coal, at $8		4,800
One engineer at $5.00 per day; one assistant engineer at $3.00 per day; two stokers at $2.50 per day—labour of station per day	13.00	
Yearly cost of labour at station		4,745
Cost of labour per day, 22 trains	88	
Yearly cost of labour upon cars		32,120
Total yearly cost of operation		158,379

COMPARISON OF RESULTS.

By Horses.		*By Electricity.*	
Capital invested	$225,000.00	Capital invested	$289,360.00
Earning capacity	177,000.00	Earning capacity	354,000.00
Running expenses, including interest—best year out of ten	109,315.20	Running expenses, including interest	78,351.00

Power consumed, and, consequently, the cost of operation the same whether you carry 3,000,000 passengers or 2,000,000.

Want of flexibility as regards ability to regulate the capacity of the road in accordance with the varying demands at different periods throughout the day.

More details to attend to. Such as buying and disposing of horses. All of which makes more clerical work and largely occupies your own personal attention.

More at the mercy of unscrupulous *employés*, as regards the attention they give your horses.

Want of flexibility of the system renders it necessary to at times overcrowd the car, and thus is the road made unpopular.

Capital confined to street railroading.

Power consumed, and, consequently, cost of operation, more nearly proportionate to the work done, or the *earnings*.

Great flexibility—rendering it possible to exactly adapt the capacity of the road to the varying demands.

After plant is once established but little attention is required outside of keeping same in repair.

Amount of attention and care given to machinery manifest on the surface.

Great flexibility (that is ability to change the capacity of the road to suit varying traffic) renders overcrowding unnecessary, and have the road become more *popular* and more generally patronised.

Power may be distributed throughout the district amounting to 2,000 horse-power with same street plant and but little additional yearly expense, and bring in an income of over $300,000 a year.

LEGAL.

The Liquidators and a Contributory.

IN RE THE UNION ELECTRIC LIGHT AND POWER COMPANY (LIMITED).

This case was heard before Lords Justices Baggallay and Fry in the Court of Appeal on Monday, 26th January.

This was an appeal by a contributory (Mr. Andrew Hutton) from an order of Mr. Justice Pearson on the 6th of December last, refusing to remove the liquidators, Mr. Wilwyn Parish, Mr. Alfred Parish, Mr. John Goddard, jun., and Mr. James Fyfe, former director, in a voluntary winding-up.

Lord Justice BAGGALLAY in giving judgment, said this was an appeal against an order of Mr. Justice Pearson, on the 6th of December last, dismissing an application to have removed the four gentlemen who had been appointed liquidators of the Union Electric Light Company (Limited). Mr. Justice Pearson had thought that it was not a case to move some of the liquidators, but a case for removing all or none, so he simply dismissed the application. Now, this company's history was not an inapt illustration of the way in which many companies were born, lived, and died. The Company was registered with a capital of 300 shares, £100 each; its object was to buy certain electric light patents. They were told that the history of the Company was this—that a syndicate had been formed for the purchasing of those patents, and to sell them again at a profit, and they thought it would be more convenient to form themselves into a company, not for trading, but for speculation. Well, that was not the purpose for which a company ought to be formed at all; however, it was formed on the 3rd April, 1882, and an agreement was entered into with a Mr. Fyfe (who was subsequently appointed one of the liquidators), the vendor, who was to sell certain specified Letters Patent for £10,000 in cash, £5,000 of which was to be paid on the signing of the agreement, and £5,000 more on the company being formed, and two-fifths of the nominal capital in fully paid-up shares—that was to say, out of the company formed with £250,000 capital he was to have £100,000 in fully paid-up shares, and if he procured certain foreign patents for the company he was to have a further sum of £5,000. Whether it was a high price or a low price he (Lord Justice Baggallay) was not prepared to say, but the gentleman who was appealing was perfectly well aware of the facts, as he was originally one of the syndicate. This showed the very large interest Mr. Fyfe had in the company. Well, the company carried out its object by selling to another company, the Pilsen-Joel and General Light Company, the English patents for £15,000 in cash and 12,000 £5 shares, probably intended for distribution amongst the shareholders in the Union Company. These Pilsen shares at one time rose to £4 10s. premium, but eventually, when realised, fetched £1 3s. each, which was a very considerable discount. There were substantially the same Directors of the Pilsen Company as of the Union Company, with which the Court was now dealing, and the suggestion had been made that these shares, which at one time might have been realised at a premium, were kept back in the interests of those Directors of the Union Company who were also Directors of the Pilsen Company. Now, amongst the voluntary liquidators who were sought to be removed were the four directors of the Company. He (the Lord Justice) did not for one moment say that the Directors of a company in a voluntary liquidation were not proper persons to be appointed. Hence the suggestion was that the four voluntary liquidators of the Company—one being Mr. Fyfe, the vendor—were not the right persons to investigate the affairs of the Company. With regard to the first point, namely, that there was a large loss in respect of those shares which might be deemed a subject of inquiry, though it certainly was a very singular transaction, he did not say that necessarily it was a charge that would be established. He presumed that the shares had arrived at a considerable discount when it was set forth in the report to the shareholders that if there should be

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some improvement in electric lighting prospects it was possible the shares in question might fetch their full value. At those meetings the matter seemed to have been fully discussed, and the majority of the shareholders appeared to have been favourable to the course that had been taken, and on that ground it did not appear to him to be a reason for changing the liquidators. Another point was that the company having sold all its English patents, and having no power to grant any licenses for the use of those patents in England, the directors went to considerable expense (£2,000) to obtain provisional orders. It certainly seemed a large expenditure to have made at a time when the company had no patents whatever in England. He should have thought that this was almost a *primâ facie* ground that there was an error in what they had done, and that it was better that some independent liquidator should be appointed. The report for the general meeting in 1883, giving all the accounts down to that time, including this item, was passed and approved at the formal meeting, and he was disposed to think that the gentleman now appealing must be presumed to have been aware of these matters, and if he chose to stay away from the meeting he must take the consequences. Therefore, upon that ground he thought this gentleman was precluded from raising the point afterwards. Another point was that £1,600 had been paid to the Directors ; but that sum did not appear to him to have been a large amount in excess of what the articles provided, and no doubt that was a matter entirely within the scope of the company ; and the chief ground of complaint was that one or other of these gentlemen were not duly qualified. But at the time one had gone to America for a purpose which seemed satisfactory to the other Directors. Therefore, that was not a point to attach much importance to in itself. He came now to a circumstance which appeared to him of a very much graver character. On the 19th March, 1884, when the company was approaching its death, an agreement was entered into between Mr. Fyfe, the vendor, and the company, itself represented by himself and the three other Directors at the time, and it would seem by it that Mr. Fyfe was to some extent indebted to the company. The agreement stated, "And whereas there have been divers further transactions with reference and the rendering by James Fyfe of certain services and providing by him of offices, materials, &c., and the said James Fyfe claims a considerable balance is due to him, which the company does not admit." Then an agreement was come to by the company to pay him £100. Well, there again, if this had been brought before the shareholders at their general meeting, he should have thought, if they had chosen to adopt the terms, that would have been sufficient to bind them ; but he could not find that any such communication had been made to them. They were invited to meet and resolve on liquidation, but were not informed of this, and they confirmed the resolution of the voluntary liquidation passed on the 26th August ; and before the month of August a certain document was sent round and signed by a number of the shareholders, including Mr. Hutton. The document was in these terms:—"We, the undersigned shareholders, hereby approve the proposed reconstruction of the company, and agree to vote for the resolutions." Substantially it had reference to a certain agreement with reference to the reconstruction. The meeting was held on the 22nd, and Mr. Hutton was present, and the minutes say the resolution was passed "nemine contradicente." Mr. Hutton says he did not vote for it, but it does not seem that any one earnestly opposed it. Subsequently, on the 29th September, when the formalities of the reconstruction were apparently over, and on the footing of a deed produced, dated the 29th December, an agreement was expressly entered into by the four liquidators of the company and Mr. Funnell, the secretary of the newly-formed company, and it referred to all the resolutions passed at the general meeting held on the 22nd August, 1884. This document was presented at the meeting on the 22nd August, at which Mr. Hutton was present, and it contained no less than four clauses, all introduced for the purpose of giving effect to the provisions. It was, he thought, preposterous for this gentleman now to come forward and say he was kept in ignorance of it, as he had an opportunity of considering it, and for him afterwards to turn round and say, though it was true he signed the memorandum and was afterwards present at the meeting and had not opposed it, that it was a document which was concealed from him. There was one other matter which he (the Lord Justice) must refer to, because he was bound to say he did not like these things, and did not think them nice in the history of the company ; but, at the same time, if they had been adopted by the shareholders, the Court could not afterwards interfere with them. There was no intimation whatever given as to the purposes of the general meeting after the liquidation. Mr. Hutton endeavoured to obtain information, and they refused to give him any. He thought that was a very serious breach of duty. This person had let them know that he had not taken the same view as the other shareholders did, and wanted to know what was going to be done at the meeting irregularly called. He had come to the conclusion, having regard to all the facts of the case, that the Court ought not to interfere with the decision of the learned Justice below refusing to remove the liquidators, but that no costs should be allowed, and by that he did not mean to say that the parties were to get their costs out of the estate.

Lord Justice FRY concurred, and added that he had no doubt of the jurisdiction of the Court to remove liquidators, but at the same time the exercise of the discretion of the learned Judge below would always have great weight with that Court. That the liquidators in this case had been guilty of impropriety of conduct he had not the slightest doubt. With regard to the meeting of October, 1884, that meeting they summoned for the purpose of considering their acts as liquidators, and they appeared to him to have had in their minds the intention of closing the mouth of Mr. Hutton in case he should raise any objection to their proceedings, when it was their bounden duty to give due notice to the shareholders of the character of the meeting ; and having regard to the great impropriety of the liquidators, they would have to pay the costs of this appeal personally.

COMPANIES' MEETINGS & REPORTS.

Eastern Telegraph Company (Limited).

The half-yearly general meeting of the shareholders in this Company was held on the 29th inst. at the Cannon-street Hotel, under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. George Draper) read the notice convening the meeting and the report of the Directors, which has appeared in *The Electrician*, was taken as read.

The CHAIRMAN stated that the gross receipts for the half year ended September 30 last had been £309,569, being an increase of £26,499 over those of the corresponding period of 1883. About £19,000 of that increase had been derived from long Government and Press messages, which had compensated the Company for the falling off in the number of commercial telegrams. The Black Sea Company's traffic showed the sum of £2,023 against £623 in the corresponding period of the previous year, which had to bear the cost of two repairing expeditions. During the six months under review they had had no interruption of the Black Sea line. Their receipts for traffic with India had been £4,000 less. The balance sheet showed that they had £3,498 in shares of the Mediterranean Extension Company, which was now in liquidation. They anticipated that this amount would be realised at a profit before the next accounts were published. Their working expenses had been £84,907, or £4,058 more than in the corresponding half of 1883. This increase had arisen for the most part from exceptional charges, which he alluded to. The salaries and wages at stations had been £2,045 more, but they had opened four new stations—Suakim, Pireaus, Patras, and Katacolo. There were also six months' working expenses of their new station at Glasgow against two months of the corresponding period. The cost of the Lipari and Messina cables had in the past half year been £884, against £1,000 for the last five half years, and the capital cost of these cables—£5,884—had now all been charged to revenue. The expenses attending repairs and renewals of cables had been £31,189, or £1,669 more than in the corresponding period of the previous year. After charging all expenses, including income tax on the net revenue, providing for interest on debentures, debenture stock, and preference shares, they were enabled to pay a dividend with bonus at the rate of 6 per cent. per annum, and to carry forward £30,364, against £13,679 in 1883. With regard to the traffic with India, they knew very well now, from long experience, that the success of the telegraph system—or an increase or decrease in the number of messages—depended more or less upon the state of trade ; and there had been a very marked depression of trade both in India and England. They nevertheless presented a good account, a circumstance which was owing to the state of things in China. He would, however, rather trust to buoyant and active trade than to war operations for a successful return on their enterprise. The next matter he had to refer to was one of considerable importance. When the report was printed it was stated that all their cables were in perfect working order. That was fourteen days ago. That day, however, they had several cables interrupted, but, thanks to their arrangements and to having their ships placed at a proper point to meet immediate repairs and requirements, he trusted that within a very short time indeed they would have their cables at work again. He wished particularly to impress this point on them—that while they had breaks they knew where the breaks were, and had perfect confidence in being able to repair them. This, however, necessitated their having ships at different points, and they were more or less expensive. Still, they could not do without them. They now had their system so arranged in the Mediterranean that if they had one, two, or three—or even four—cables interrupted they would still be able to conduct their important traffic with the Continent and their large traffic with India, China, and Australia. They had—possibly what the shareholders were not aware of—many alternative routes. During the present pressure of war intelligence and urgent messages on military affairs they had been enabled to utilise their two cables from Alexandria to Malta and Marseilles, secondly those from Alexandria to Zante and Otranto, and thirdly from Zante to Trieste, and from Alexandria to Constantinople and Odessa. They had these four important alternative routes to the Continent and Egypt, besides the line *viâ* Gibraltar and Lisbon, which had been totally interrupted for the last five days. They were therefore now, with many interruptions, still doing their work in a way which the public could have no cause to complain of. He was sure they would all join with him in expressing deep regret at the loss which the nation had sustained by the death, at the seat of war, of Mr. Cameron, the special correspondent of the *Standard*, and of Mr. Herbert, the special correspondent of the *Morning Post*. He did not consider it at all out of place at that meeting for him to refer to the splendid services which the correspondents of the daily newspapers rendered to their employers and the public ; and he might mention, incidentally, that on more occasions than one they had received telegrams from these gentlemen which had cost the papers they represented from £300 to £500. The last time he addressed them he stated that they had connected Suakim with their system, and that Suakim was likely to be the opening to the Soudan. It was at that time generally supposed that any expedition sent from this country would go by Suakim to the Soudan. When he looked at the hundreds of thousands of pounds spent in going in that direction compared with the millions spent in going in other directions, and when his opinion was more the opinion of men of great experience, he regretted on many accounts that Suakim was not the road by which the Soudan had been approached. If the railway had been made it would have developed a new trade in that country, have prevented the slave trade which England had done so much to keep down, and in every respect he believed the result would have been more satisfactory had we gone to the Soudan by Suakim. He sincerely trusted, however, as it was, that the outcome of the course which had been taken would be

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beneficial to the nation. They had now obtained possession at a moderate price of the undertaking of the Mediterranean Extension Telegraph Company; and they had also acquired a controlling interest in the Direct Spanish Telegraph Company. These were now links—and they might ultimately become important links—in the Company's system of cables. The arrangement made with the Greek Government—to which he had alluded at their last meeting—was regarded as so satisfactory by that Government that they afterwards offered the Company an extension of the subsidy of £6,500 a year for ten years, making thirty-three years, if they would connect some of the outlying islands of Greece. The fresh connections would cost the Company about £6,000, so that, on the whole, this was not an unsatisfactory arrangement. They had also opened a station at Perim, in the Red Sea. They had done this under a guarantee from an enterprising company established there—the Perim Coal Company—that their expenses should be paid, and they expected that the traffic from that place would be something considerable eventually. The whole of our mercantile fleet was composed of steamships which must coal somewhere; and what was the value of our great ironclads if we had not good coaling stations? He believed this was going to be a great question of the day, and it was the interest of this Company "to follow the flag" as far as they could. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (the Marquis of Tweeddale) seconded the report.

The CHAIRMAN, in reply to questions by Messrs. E. P. Evans, Watkins, John Newton, and Sherwin, stated that the reserve fund was the backbone of a cable company. As to placing the interest of the reserve fund to the general revenue account, instead of adding it to the reserve fund, if the accountants could be induced to sanction it, he did not think the Directors would be found difficult to deal with in the matter. They received no dividend on the shares of the Direct Spanish Company, but they had 6 per cent. on the debentures.

The resolution was then unanimously adopted.

The retiring Directors—Mr. Pender and the Marquis of Tweeddale; and the auditors—Messrs. Henry Dever, and Messrs. Quilter, Ball, and Co. were afterwards reappointed; and a cordial vote of thanks to the Chairman, Directors, and staff brought the proceedings to a close.

[We shall publish a full report of this meeting in our next issue].

Cuba Submarine Telegraph Company.

The twenty-seventh ordinary general meeting of this Company was held on Wednesday, at the offices, No. 61, Old Broad-street, Mr. Joaquin de Mancha presiding.

The SECRETARY (Mr. James Scott) read the notice convening the meeting, and the report was taken as read.

The CHAIRMAN: Well, gentlemen, the report and accounts having been taken as read, I must offer a very few observations, for I consider that they so clearly and substantially convey the whole of the proceedings of the last six months that it requires but very few observations on my part. I think we must congratulate ourselves that the report is so very favourable, taking into account the great difficulties that all sugar-growing countries have experienced during the last few months. We find, notwithstanding, that Cuba has produced for us 981 messages more than at the same period last year, which I think is very satisfactory for our interest. I am only sorry to say that the receipts have not kept up in the same proportion, for although we have carried more messages our income has been about £400 less than it was in December of the previous year. That, as I have before explained arises from the great knowledge that gentlemen who use the telegraph now possess; they are more versed in conveying messages, and one word very often includes a whole sentence. I know for myself that we have one word which signifies "We have paid into your account," or "We cable £5,000 to the credit of Mr. So and So, Barcelona." Therefore one word conveys the whole gist of all the telegram which, in former times, used to be more explicit than it is now. You see, gentlemen, that besides having added to the reserve fund, its own interest—which amounts to £1,400—we have been able to add out of the profits of the half year £550 more, bringing up the reserve fund now to £60,000, which, I think, you will consider a very favourable amount to have at our disposal [applause]. This sum we of course hope to continue adding to, for telegraph and cable property is rather dangerous, and very often breaks down, and it might be unacceptable to find an expenditure of £4,000 or £5,000, or it might be, as at one time, nearly £20,000. Therefore my colleagues and myself consider that it would be advisable to allow that fund still to accumulate [applause]. The money we have in hand, you will see, will enable us to pay the £3,000 on the preference shares, and we recommend to you that a dividend, free of income tax, be paid at the rate of 7 per cent. for the half year, which will absorb the whole of the amount except £400, which we will carry forward to the next account. In paragraph 5 it is very satisfactory to find that the cables are all in excellent repair. We have had letters lately from Mr. Keith, our engineer, who says they are all working in perfect order, and we hope they will continue to do so. It has been necessary for us to buy a small piece of land for the putting up of tanks for some cable we have there in case of necessity. This has entailed the expenditure of a trifling sum, which rather increases the expenses as you will find, but it is not very large. It amounts to about £177, but it is an expenditure which we consider is well laid out, and it has enabled us to have our spare cable re-coiled, so that in case of necessity it will be available for our purposes [applause]. As to the old question of the tax to be returned by the Spanish Government, when this report was written it had not yet been received, but since then we have had a letter from Mr. Keith, and also a telegram, by which it seems that the Government have not funds at present to pay us, but they promise to do so. The telegram was received yesterday, and the Secretary will read it.

The SECRETARY, reading: "On Monday Crow says our claim will be paid out of first cash remittance received from Spain. Expected about 5th prox." That is the 5th of February.

The CHAIRMAN: So that we hope that paragraph will be expunged from our next report, and that we shall be able to tell you that the sum of about £1,100 has been received and carried to profit and loss. I think, gentlemen, these are the few words I have to call your attention to, and therefore I will now ask you to pass the resolution—"That the report and accounts now submitted be received and adopted" [applause].

Mr. ALEXANDER F. LOW seconded the resolution.

Mr. WOODWARD asked for some information as to the item of loan on securities, £4,000; also as to the amount of sundry creditors. He also considered that the sum of £10,000 lodged with the banks on deposit was too large. It was not wise to put so many eggs in one basket, and he would therefore be prepared to move as an amendment "That no larger sum than £5,000 of this Company's money be lent to any one bank, or for a longer period than six months."

Mr. PREST, while congratulating the Board on the excellent way in which the Company's affairs had been administered, would be ready to second this amendment as a matter of precaution.

Mr. GRIFFITHS thought it would be wise to accept the report, and bring forward this proposal as a separate resolution. He complimented the Board on the manner in which they had managed the Company's affairs, and asked the time for which the concession would still run.

The CHAIRMAN said he would answer the questions they had placed before him. First of all, Mr. Woodward had inquired what security they had for the loan of £4,000. That was the spare money they had in hand for the dividend, and as they could not employ it in anything more profitable than lending it on the Stock Exchange, they lent it to a very respectable broker on securities that were worth £6,000 [applause]. By that means they were able to get 4½ per cent. They had called up the money that day so as to be ready to meet the dividend. He thought it quite right that gentlemen should ask questions, and they would answer them all, he hoped, to their satisfaction. The next question was about the sundry creditors. He had them all there. First of all there was an amount which they had to pay to Mr. Hooper for the cable that they were then using. He did not know whether that gentleman had been here before.

Mr. WOODWARD: No.

The CHAIRMAN thought he had explained before that they had to pay so much a year—£4,000 a year. They had paid £2,000 out of the profits this year, and that was the amount they had to pay Mr. Hooper as the proportion of the cable up to the present time. That amounted to £2,962. They got that back in case of any fault being found. Mr. Hooper was bound to repair it at his own cost, therefore they had retained a certain sum which went on accumulating until it gets to £5,000, when he got his full allowance. Until then they retained a certain portion, so that in case of an accident they had a guarantee that the cable would be repaired.

Mr. GREENWOOD (the auditor) said he did not think it was wise that those matters of detail should go out to the general public.

The CHAIRMAN believed they had nothing to hide. As to the other sums, there was a reserve for the income tax and an amount they owed to Mr. Ramsden, one of the managers. They had plenty of money to pay for them. The next thing was the deposits with the banks. Most of the gentlemen present knew about banking, and that it was a very difficult thing at the present time to employ money at 5 per cent [applause]. A gentleman said that there were plenty of things knocking about to pay 4½ per cent. He wished he would only send a list of them, and he would be glad to invest in them. He knew there there was the greatest difficulty in getting 3½ interest on railway debentures. He hardly thought there was a railway in England which would pay more than 3½ per cent. [applause]. He thought the question was for them to say what they wished done, but he should not like to have Mr. Woodward's proposal put as an amendment [applause]. They would express their ideas that they thought it would be more prudent not to have more than £5,000, and if they left it for the Board to deal with they would endeavour to bring it down to that figure. There was the Chartered Bank of India. They had £10,000 in that bank, which he knew was refusing money. In that bank they had not only the security of the paid-up capital of the bank, but more than that; and even in the case of the Oriental Bank, the whole of the depositors he believed would get every shilling which was owing to them. This was not like a private bank in England in which there were no shareholders. In most of those banks there were perhaps 1,000 or more shareholders, and if the bank went wrong they were liable for double the amount which they had subscribed. Therefore, though it might seem a large sum deposited with these banks, he must say that any gentleman who knew anything about the business would feel perfectly satisfied, even if they had ten times that amount with them.

Mr. WOODWARD objected to the sum of £10,000 in any bank.

The CHAIRMAN said that was a matter they would bear in mind, and he would be sorry if that question were put as an amendment. He did not think, indeed, they could put it as an amendment. None of those banks would receive money for less than a year, and some for sixteen months. They required three months extra, so as to get the money from the Colonies if they called it in.

Mr. WOODWARD contended that that made his argument stronger.

The CHAIRMAN, in reply to Mr. Griffiths, said that the concessions had still about thirty years to run.

Mr. WOODWARD here intimated that he would be happy to withdraw his amendment, and the report and accounts were unanimously adopted.

The CHAIRMAN next proposed "That the following dividends for the half year be now declared upon the shares of the Company, viz., at the rate of 10 per cent., subject to income tax, on the preference shares; and at the rate of 7 per cent., free of income tax, on the ordinary shares, payable on and after to-morrow."

Mr. LOW seconded the resolution, which was agreed to.

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Mr. WOODWARD then proposed "That it be a recommendation to the Board to distribute their investments, so as not to have more than £5,000 in any one security."

Mr. PREST seconded the resolution, which was carried.

On the motion of Mr. GRIFFITHS, seconded by Mr. WOODWARD, a cordial vote of thanks was passed to the Chairman and Directors, and the proceedings terminated.

The Direct United States Cable Company (Limited).

Report of the Directors for the six months ended 31st December, 1884, to be presented at the fifteenth ordinary general meeting of the Company to be held at the Cannon-street Hotel, on Thursday, February 5th, at 2 p.m.:—

For the half year the revenue, after deducting out-payments, amounted to £68,824 5s. 2d., against £73,472 12s. 7d. (after similar deductions) for the corresponding half year of 1883, being a difference of £4,648 7s. 5d. against the half year under review. The working and other expenses, including interest on debentures and income tax, &c., amounted to £18,607 15s., leaving a balance of £50,216 10s. 2d. as the net profit of the half year, making, with £2,786 8s. 7d. brought forward from the previous half year, a total balance of £53,002 18s. 9d. For the corresponding half year of 1883 the working expenses and other payments amounted to £21,824 4s. 5d. Interim dividends of 1¼ per cent., each for the quarter ending 30th September, 1884, paid 15th November, 1884, and for the quarter ending 31st December, 1884, payable 16th February, 1885, together amounting to £30,355, have been declared. The sum of £5,396 15s. 10d. has been set aside to the reserve fund, which after being charged with £73,367 14s. 7d. on repayment of the debenture loan now amounts to £300,000. A balance on the revenue account of £17,251 2s. 11d. has been carried forward. The debenture loan of £100,000 was paid off on the date due, viz., 15th October last. On the 24th December last, the Mackay-Bennett cables opened for business at a tariff to New York of 1s. 8d. per word. The tariff of this Company was on that date reduced to the same rate.

Anglo-American Telegraph Company (Limited).

Report of the Directors to the ordinary general half-yearly meeting of the proprietors to be held at the City Terminus Hotel, Cannon-street, on Friday, February 6th, at 2 p.m.:—

The total receipts from the 1st July to the 31st December, 1884, including a balance of £2,503 11s. 5d. brought forward from the last account, amount to £243,066 12s. The traffic receipts show a decrease of £12,136, as compared with the corresponding period of last year. The total expenses of the half year, including repair of cables, &c., as shown by the revenue account, amount to £52,639 17s. 4d. The Directors, under the powers conferred upon them by the Articles of Association, have, before declaring the net profits, set apart the sum of £75,000 to the renewal fund, leaving a balance of £115,426 14s. 8d. Interim dividends of 15s. per cent. on the ordinary stock, and 30s. per cent. on the preferred stock were paid on the 1st November last, absorbing £52,500, leaving a balance of £62,926 14s. 8d., out of which the Directors recommend the proprietors to declare final dividends, less income tax, of 17s. 6d. per cent. on the ordinary stock, £1 10s. per cent. on the preferred stock, and 5s. per cent. on the deferred stock, amounting to £61,250, making a total distribution for the year ended the 31st December, 1884, of £3 2s. 6d. per cent. on the ordinary stock, £6 per cent. on the preferred stock, and 5s. per cent. on the deferred stock, leaving a balance of £1,676 14s. 8d. to be carried forward to the next account. The Company's repairing ss. "Minia" has been engaged during a portion of the past half year in the repair of the Rantem and Island Cove cables. She has also been engaged in the repair of the Western Union Telegraph Company's cables off the Great Bank of Newfoundland, having been chartered by that company for the purpose. The Company's system of cables and land wires is in good working order. The Commercial Cable Company (Mackay-Bennett) opened their cables to the public on the 24th December, 1884, at a tariff of 1s. 8d. per word from the United Kingdom, and 2 francs per word from France to New York and Canada, and at 40 cents per word from New York and some of the principal cities in the United States to the United Kingdom and France, being an average reduction of about 20 per cent. The Atlantic cable companies parties to the joint purse agreement adopted the above rates from the same date. In consequence of this reduction, a loss estimated at about £170,000 a year will be incurred by the companies engaged in carrying the traffic, there being no reasonable expectation that this decrease of revenue will be recouped to the companies by an equivalent or even appreciable augmentation in the number of messages. In accordance with the Articles of Association, two Directors of the Company, Sir James Anderson and William S. Cunard, Esq., retire at this meeting, and, being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. Francis Glass, the auditors, also retire and offer themselves for re-election.

Dundee and District Telephonic Company (Limited).

Report by the Directors to the annual general meeting of the shareholders to be held on Wednesday, February 4, 1885, at 12 noon:—The Directors have pleasure in submitting to the shareholders the accounts and balance sheet of the Company for the year ending 31st December, 1884. In terms of a resolution come to at a meeting of the Company held on 6th February last, and duly confirmed by a meeting held on 21st February last, the capital of the Company has been increased from £5,000 to £10,000. Of the new shares authorised to be issued 372 shares of £5 each have been subscribed for, and on these the sum of £2 5s. has been called up and duly paid. The number of wires rented at the close of the year was 340, being an increase of 20 on the previous year, which, considering the opposition with which the Company has to contend, the Directors regard as gratifying. The net balance of revenue amounts to £633 13s. 7d., which the Directors recommend should be applied as follows:—To reserve fund (which will then amount to £800), £200; to payment of a dividend at the rate of 5 per cent. per annum, free of income tax, £252 17s. 3d., leaving a balance of £180 16s. 4d. to be carried forward to next account, subject to such remuneration as may be voted to the Directors.

Anglo-American Brush Electric Light Corporation.

Report of the Directors for the year ended 31st Dec., 1884:—

The need for a lengthy report upon the proceedings of the Corporation during the past year is lessened by the publication in July last of an *ad interim* report, which informed the shareholders of the business and progress effected during the first half of the year, and by the issue of the circular in view of the extraordinary general meeting, on 22nd December, at which the provisional agreements for the absorption of the Great Western Electric Light and Power Company, and the Brush Midland Electric Light and Power Company were adopted. The shareholders will have concluded from the half-yearly report already referred to, as well as from the universal depression of trade throughout the country, that the expectations of a revival of business entertained a year ago have not been realised to the full extent. Nevertheless, the Board have the satisfaction of being able to congratulate the shareholders upon the great advance made by the Corporation, and upon the decidedly improved position which electric lighting occupies among the industries of the world. The progress made by the Corporation in perfecting its apparatus and in extending its business has been very considerable, and, consequently, good progress has been made, as will be seen from the accounts, towards attaining a dividend-paying position. This advance is in a large measure attributable to the fact that the Corporation have extended the scope of their operations by undertaking the work of contractors, and to their having secured important and remunerative contracts from the Government, and other sources for the installation of the electric light; and the Directors are glad to recognise in the cordial manner in which the proposal to amalgamate with two of the subsidiary Brush Companies was agreed to, that the shareholders appreciate and support the policy of the Board, which renders possible this extension of the sphere of operations. The concentration of the manufacturing works, begun in 1883 by the removal of the incandescence department from Portpool-lane to Victoria Works, proved so marked a success, both directly and indirectly, in the reduction of expenditure, and in the increase of general efficiency which resulted therefrom, that the Board determined, after careful consideration, to continue this concentration by arranging that the operations hitherto conducted at the Borough-road premises should be carried on as far as practicable at the Victoria Works. The economical advantages resulting from this concentration of work are not fully reflected in the accounts for the past year, inasmuch as the new arrangement was not completed until quite recently, but the course adopted will, it is hoped, during the current year, contribute materially towards a further appreciable reduction, both in the cost of manufacture and in the standing charges. The shareholders were informed at the last annual meeting that an understanding had been come to, subsequent to the issue of the report, with the British Electric Light Company, by which the action instituted by that Company against the Corporation was abandoned, it being admitted that the Brush machine in no way infringed the Gramme patent. A satisfactory settlement was also arrived at with Messrs. Latimer Clark, Muirhead, and Co., between whom and the Corporation cross actions were pending with regard to disputed accounts; and an arrangement has been made with the Hammond Company by which they have, for a consideration, been released from their contract to re-purchase the apparatus returned by them under the agreement referred to in the last report. The Directors regret the heavy loss sustained by the Corporation in connection with the law suit, *re* Muir and Co., reported to the shareholders in July last. The Corporation are now, however, happily not involved in any litigation, and the Directors trust that the exceptional items of law charges which have hitherto absorbed so large a proportion of the gross profits will find no place in the future profit and loss accounts of the Corporation. The Board, however, cannot but regard it as their first duty to take such steps, with a view to the maintenance and protection of the valuable patent rights of the Corporation, as may from time to time become necessary, and to exercise due vigilance in detecting and taking proceedings in respect of infringements. The Directors felt it incumbent upon them to take active steps to obtain adequate amendments in the legislation with regard to electric lighting, and early last year the Corporation directed the attention of the public to the unprecedented and exceedingly onerous conditions imposed upon electric lighting contractors by the Act of 1882, which is so largely responsible for the delay in the establishment, on a large scale, of central stations, in the absence of which the supply of electricity for house-to-house lighting cannot be economically undertaken. Later in the year a deputation to the Board of Trade was organised by the Chairman, and, as the shareholders are already aware, the interview with the President of that department was of a character to encourage the hope that a fair and reasonable proposal of reform will be favourably received by the Government. To judge from the feeling of the public, as expressed by the press, the country now generally recognises that an important industry is suffering from unduly repressive legislation. Since the time when the deputation waited upon the Board of Trade, a powerful and representative committee has been constituted to formulate, at the request and for the consideration of the Board of Trade, the views of the

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electric lighting companies, and others interested in the matter, as to the nature of the amendments required. The cause of reform has also been very materially promoted by the independent action of other bodies. A very excellent report upon the subject has been drawn up and submitted to the Board of Trade by a society of electrical ennineers ; and public opinion may fairly be said to be aroused in the matter, so that it may reasonably be hoped that the injury unintentionally inflicted upon electric lighting by Parliament will speedily be remedied. The manufacture of the improved Brush armature has been systematically proceeded with, and the results obtained exceed the expectations formed regarding it. By its use the output of the Brush dynamo is increased by fully 40 per cent., and the efficiency is also very greatly increased. These new armatures are made interchangeable with the old, and no other part in the machine requires alteration. A considerable demand already exists for them, and it may be confidently expected that this demand will increase, and that every machine in use will be ultimately so fitted. The Ratchet lamp (Brush-Sellon patent) of which mention was made in last year's report, has also been well introduced, and has given complete satisfaction as an almost absolutely steady and unflickering arc lamp. The system of manufacture pursued in the case of this, as well as of the Brush lamp, is the same as that for the dynamos—namely, to secure an interchangeability of parts. At the same time the Brush lamp still holds its own as the most simple, reliable, and enduring lamp for arc lighting in exposed situations. In the incandescence department satisfactory progress has been made. The Victoria machine has fully maintained its high position as the leading machine for incandescence lighting in the market. Great improvements have been made in its armature with excellent result, and various minor but substantial improvements have also been introduced, without increasing the price, and not only has the cost of production of the machines been materially reduced by the organised system of manufacture, but the Victoria as well as the Brush dynamos are now made so that the parts of similar machines are interchangeable, thus increasing their relative value, and enabling the Corporation to sell at higher prices. Special attention is being given to the manufacture of lamps of high candle-power, and the Victoria lamp takes a prominent position amongst the best known incandescent lamps. In connection with the extension of the business of the Corporation as contractors for installation work, it became necessary to work out complete sets of fittings, for ship, factory, and private lighting, and the production and sale of these will henceforward form an important part of the business of the Corporation. The capital account has been increased by £7,992, the amount received from holders of partly paid shares in the exercise of the option given them of making their shares fully paid. The maximum number of fully-paid shares the Corporation are eventually liable to issue to the shareholders in the Great Western and Brush Midland Companies is stated in the balance sheet, but the actual amount of capital that will ultimately have to be issued is dependent upon the number of fully-paid shares in these companies that will be surrendered. The total amount owing by the Corporation to creditors and on bills payable is £3,726 6s. 4d., and as the good debts due to the Corporation amount to £19,560 16s. 8d., and the cash at their credit with the bankers and in hand stands at £10,541 4s. 2d., the satisfactory position of the Corporation will be at once realised by the shareholders and the public. The amount of the provision against shares held by the Corporation in subsidiary companies has been reduced from £99,200 to £50,000, the shares of the Brush Midland Electric Light Company, Great Western Electric Light Company, and Eastern Electric Light Company, having been eliminated from the contra account, owing to these companies being now in voluntary liquidation. The patents account shows an increase of £3,676 12s. 11d. upon last year's valuation. This increase represents the cost of maintaining the English and foreign patents, and of the experiments and other initial steps necessary to obtaining patent protection for the several inventions which have been developed in connection with the advance made by the Corporation in the various branches of its manufacture, and in introducing the new machines and apparatus. Under the head of appropriation of profits, the Directors recommend the reduction of patents account by the amount of £1,500 as a matter of principle, and not because they believe that there is anything either in the present aspect of affairs or in the general progress of electric lighting to call for a depreciation of the value of the patents possessed by the Corporation. The events of the year have really tended to increase the intrinsic value of these patent rights, and the Board are of opinion that the figure at which this asset stands in the books represents its minimum value. As a result of the concentration of the manufacturing arrangements, a considerable amount of the plant, fixed and otherwise, at the Borough-road and Portpool-lane premises, has been consigned to stock, and will be further employed or eventually realised as opportunity offers. It has consequently been deemed advisable to have a careful revaluation and readjustment made of the property and stock accounts, the result being to reduce the property account to £40,147 9s 6d., and to increase stock account to £69,171 11s. 1d., the latter figure representing the minimum cost value of the stock on hand, stores, and goods in course of manufacture. In view of the extremely low figure at which property stands in the books, and having regard to the increased efficiency resulting from the concentration of the works, it is not thought necessary to make any reduction this year in respect of depreciation. The amount of £413 7s. 4d. representing premiums on insurance, rent, &c., paid in advance on account of 1885, and not therefore chargeable against last year's revenue, has been carried to a suspense account. The item "Assets Realisation Accounts £29,475" represents the gross value of the assets to be transferred from the Great Western and Brush Midland Companies, in addition to the £4,000 cash which has been already received. The absorption of these companies was not effected in time to enable the various assets to be incorporated in the books of the Corporation under their respective heads, but it is estimated that when the liquidation of these companies has been closed, the undermentioned accounts will be increased as follows :—

Property Account.—By the value of plant at lighting stations, installations on hire, freehold and leasehold land and buildings, &c. £12,700
Stock Account.—By the value of manufactured goods on hand 4,000
Cssh (in addition to the £4,000 already received) 6,800
Patents Account.—By balance representing goodwill and surrender of Brush and Lane-Fox licenses for twenty-eight counties in England and Wales..... 5,975

In addition to the above-mentioned assets, the Corporation, as shareholders, have received from the Great Western Company £1,000. This amount has been carried to credit of profit and loss account, and will be dealt with in the appropriation of the net balance of profit. It will be seen from the profit and loss account that the result of the year's operations is a gross profit of £22,948 10s. 3d., including profit on shares in Great Western Company, proceeds of sale of patents and bad debts recovered, less provision for doubtful debts, and that after deducting all standing charges and expenses, there remains a surplus profit on the year's working of £5,743 18s. 6d., notwithstanding the heavy loss attendant upon the Muir lawsuit, and after charging sundry items more properly belonging to the previous year. From this profit, however, has to be deducted the adverse balance of £1,616 3s. 2d. brought forward from last year, leaving, as the available result of all the transactions of the past year, a net surplus profit of £4,127 15s. 4d. An analysis of this profit and loss account will show, not only a very marked improvement in the business effected, both as regards its volume and its profitable character, but also that the efforts of the Board to economise in every department have been, in a very high degree, successful. Comparison with the operations of the previous year shows that the gross actual trading profit has increased by nearly 120 per cent., while the standing charges have been reduced by more than 45 per cent. The Directors recommend, that of the amount standing to credit of profit and loss account—£1,000, being the sum received in respect of the shares of the Great Western Company—be applied to reduction of the cost of goodwill and licenses, that £1,500 be applied to the reduction of patents account, as explained above, and that the remainder, amounting to £1,627 15s. 4d., be carried forward to next account. The Directors who retire by rotation are Mr. Gibbs, Mr. Courtenay, and Mr. Ladd, who, being duly qualified, offer themselves for re-election. The Directors have pleasure in announcing that Mr. Joseph Bevan Braithwaite, jun., a member of the firm of Messrs. Foster and Braithwaite, and late chairman of the Great Western Electric Light Company, has, at the invitation of the Board, expressed his willingness to join the directorate, but as the Board are not empowered, under the Articles, to appoint an additional Director, they nominate Mr. Braithwaite for election by the shareholders. Messrs. Cooper Brothers and Co., the auditors, retire, and offer themselves for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Jan. 28.		Business Done Week Ending Jan. 28. Highest.		Lowest.
Anglo-American	31,	32	32½		31½
Do. Preferred	55,	56	56		55½
Do. Deferred	7⅞,	8½	—		—
Brazilian Submarine	10⅝,	10¾	11⅞		10⅝
Cuba	11,	11½	—		—
Do. Preference	18,	19	—		—
Direct Spanish	2,	2½	2		—
Do. Preference	10½,	11½	11		10⅝
Direct United States Cable	9⅜,	9⅞	10		9 9-16
Eastern Telegraph	11½,	11⅝	11⅝		11⅛
Do. 6 per Cent. Preference	13⅞,	14½	13⅞		—
Do. 5 per Cent. Debentures, 1899	105,	108	106		—
Eastern Extension	12⅛,	12½	12½		12½
German Union	9½,	10	—		—
Globe Telegraph and Trust	6⅞,	7⅛	7		6⅞
Do. Preference	12½,	12⅝	12⅝		12½
Great Northern	14⅜,	14⅞	14 13-16		14 9-16
Indo-European	32,	33	—		—
Reuter's	7½,	8	—		—
Submarine	175,	180	180		—
West India and Panama	⅝,	¾	—		—
Do. 1st Preference	7½,	7⅝	7½		7 7-16
Western Brazilian	6¼,	6½	6¼		—
Western Union 7 per Cent. 1st Mortgage	120,	125	—		—
Do. 6 per Cent. Sterling Bonds	100,	103	—		—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	½		—
Oriental	⅛,	⅜	—		—
United Telephone	11,	11½	11⅜		11 3-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅛,	1⅜	1⅜		1⅛
Do. (fully paid)	3⅛,	3⅜	3⅜		—
Hammond Light (£3 15s. paid)	⅝,	¾	¾		11-16
Swan	¼,	⅜	—		—
Maxim-Weston	⅛,	⅜	⅜		—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35½		34½
India Rubber, Gutta Percha, and Telegraph Works	21½,	22½	22		

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NOTES.

DIRECT UNITED STATES CABLE.—We notice that this cable is interrupted.

SOUTH AFRICAN CABLE.—This cable is interrupted between Zanzibar and Mozambique.

THE TELEPHONE IN AMERICA.—Oral communication may now be held by telephone between New York and Boston.

INVENTORIES.—We understand that Messrs. Siemens are to light up the grounds of the forthcoming exhibition by the electric light.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 30th January amounted to £3,668.

ANTWERP EXHIBITION.—The Belgian Chamber of representatives has voted a subsidy of 500,000f. (£20,000) in aid of the Antwerp Exhibition of this year.

BERNSTEIN ELECTRIC LAMP COMPANY.—We understand that this company will have the lighting of the dining rooms at the forthcoming Inventions Exhibition.

DUBUQUE, OHIO.—The electric light companies of this town have been compelled to stop work because of the constant losses, there not being sufficient demand for the light.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of January, 1885, amounted to £57,249, and to £55,503 in the corresponding period of 1884.

PERSONAL.—We hear that Mr. J. F. Albright, late engineer to the Edison-Swan Company, has resigned his appointment, and entered into partnership with Messrs. R. E. Crompton and Co.

THE TELEPHONE IN ROME.—The subscribers have appointed a committee for protesting against the yearly rate being increased from 100 to 180 lire (£4 to £7 4s.) as the company proposes.

INVERNESS.—The New Central Telephone Exchange was opened on 19th January, the first call being received at 10 o'clock; and about two hundred messages were transmitted during the day.

GAS AND ELECTRIC LIGHT COMBINATION.—At Evansville, Ind., U.S.A., the Electric Light Company has lately been fused with the Gas Company, so that either light is available for customers.

THE ELECTRIC LIGHT IN BANKS.—Last week the lighting arrangements for the Crédit Foncier, including 100 incandescent lamps, installed by the Paris Edison Company, were brought into use.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of January, 1885, amounted to £1,770, against £2,072 in the corresponding period of last year.

COMPAGNIE INTERNATIONALE DES TELEPHONES.—The 375fr. (£15) paid-up shares of this company rose from par on 26th January, to 382fr. 50c. on 2nd February, showing an advance of 7fr. 50c., or about 6s.

ELECTRICAL COMPANIES IN AMERICA.—It is reported that in the week ending December 13, eleven new corporations for electrical purposes were organised in the United States, with an aggregate capital of $1,900,000.

SNOW AND LIGHTNING IN ITALY.—Notwithstanding the fact that railways were blocked and telegraph lines interrupted owing to the recent snow storms, two peasants were struck by lightning at Corigliano, near Naples.

SHIP LIGHTING.—The Paris Edison Company has lighted the Transatlantic Company's steamer "Labrador," beginning the installation on 19th, and completing it by 24th January, when the steamer left for New York.

PARIS ELECTRICAL EXHIBITION.—The Exhibition organised by the Société Internationale des Electriciens, at the Paris Observatory, with the co-operation of Admiral Mouchez, is announced to open on Sunday, 15th March.

AND SO SAY ALL OF US.—Sig. G. de Franceschi, in a note on the watt and volt-ampere published by *Il Giorno*, thinks it highly desirable that the next Electrical Congress settle, once for all, the electrical units and nomenclature.

BUSINESS.—Messrs. Paterson and Cooper, European Telegraph Works, Dalston, have added a department to their works for the extensive manufacture and supply of every article required for the electro-deposition of various metals.

MADRID EXHIBITION, 1886.—A Spanish Royal decree, dated 9th January, enacts that an international exhibition of art and industry be held in the park of Madrid next year, the arrangements being left to an organising committee.

BRIGHTON ELECTRIC RAILWAY.—During the six months that this line has been working, the distance run by the cars has amounted to 15,600 miles, and 200,000 passengers have been carried, the total cost of traction being less than twopence a mile.

CANTOR LECTURES.—Professor Forbes gave the first of his Cantor lectures on the distribution of electricity, on Monday evening last, at the Society of Arts. We hope in due course, with the permission of the society, to give these lectures in full.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 30th January were £2,916, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

CARRE CARBONS.—We understand from Messrs. Thompson, Dowsing, and Rew, the agents in this country, that M. F. Carré, the well-known carbon manufacturer, of Paris, has taken out patents for improvements in carbons, which are manufactured by Emile Levy, of Paris.

SUGAR REFINING.—A new process was recently tried in America for sugar refining, in which the principal agent employed is electricity. The cost is said to be not more than 3s. 4d. per ton, and the result a hard sugar of almost absolute purity without any syrup whatever.

CHURCH STRUCK BY LIGHTNING.—A heavy thunderstorm visited Winchester on Saturday afternoon, when the electric fluid, descending, it is said, like a ball of fire, struck the tower of St. Cross Church. The oak shaft was shattered, one of the brethren's houses being also stricken.

ELECTRO-MAGNETIC PHENOMENA OF THE POLARISATION OF LIGHT.—The Science Class of the Belgian Royal Academy has accepted a sealed paper by M. van Aubel, of Liége, dealing with his researches on the electro-magnetic rotation of the plane of polarisation of light and similar phenomena.

THE ENGLISH ILLUSTRATED MAGAZINE.—We have received the February number of this magazine, in which there is no diminution in the beauty of the illustrations or in the value of the letterpress. It shows that the art of illustrating is not so completely lost in England as has been imagined.

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EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of January, 1885 (including Government subsidies), amounted to £44,144, and to £41,129 in the corresponding period of 1884, showing an increase of £3,015.

ELECTRICITY AND MAGNETISM.—"The action at a distance of a short closed circuit is equal to that of a short magnet placed at right angles to the plane of the circuit; and the moment will equal the product of the circuit-bounded area by the intensity of the current."—R. Ferrini (*Elettricità e Magnetismo*).

ELECTRIC LIGHT IN THE THEATRE.—The Edison lamps placed in the lustre of the Paris Opera are said to give excellent results, and to have induced the management to adopt the electric light for the approaching *bals masqués*. The dynamos work almost uninterruptedly from Friday evening to Sunday morning.

E.M.F. DEVELOPED BY LUMINOUS RAYS.—At a recent meeting of the Paris Academy of Science, M. F. Griveaux handed in a note on the results furnished by Clarke's potentiometer, applied to the measure of electromotive force developed by the action of luminous rays on a silver plate covered with salts of silver.

SOUTH OF ENGLAND TELEPHONE COMPANY.—This "limited" company, which has been formed for working and developing electrical business, and specially for carrying out an agreement made with the United Telephone Company, for telephone working, is now issuing 20,000 £6 per cent. first preference shares of £5 each.

RAILWAY STATION LIGHTING.—The French Eastern Railway Company has decided to light the platforms and waiting rooms of the Paris terminus by 9 arc and 60 incandescent lamps, to be installed by Siemens Brothers, of Paris. The Epernay station of the same company is being fitted with 20 arc lamps by the Maison Breguet.

CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of this company during the month of January was 3,556, estimated to produce £3,000, against 3,291 messages, producing £3,009 in the corresponding month of last year. The traffic receipts for the month of October, estimated at £2,200, realised £2,230.

THE SOCIETY OF TELEGRAPH ENGINEERS.—At the meeting of the society on Thursday, February 12, at 8 p.m., Captain H. R. Sankey, R.E., will deliver a lecture on "Some Experiments in Electrotyping with a Dynamo-Electric Machine;" and I. A. Timmis, M.I.M.E., will lecture on "The Working of Railway Signals and Points by Electro-Magnets."

THE OMNIPOTENT "I."—Last week an eminent firm of electric light engineers received a letter from a gentleman worded thus: "Please let me know how it is that electric light companies are handicapped by the Acts, so that I may take steps to alter this." This letter is evidently written in sober earnest, as the writer gives his full name and address.

"INDUSTRIAL AMERICA."—This is the title of a new illustrated contemporary, published at the offices of the *Electrical World*. It seems to be intended to follow somewhat in the footsteps of the *Scientific American*, but in order to compete successfully with its rival, its illustrations will have to be made for the sake of giving information and not for the sake of making its pages look pretty.

PERSONAL.—Mr. John D. Miller, formerly district manager at Greenock to the National Telephone Company, has been promoted from the office of district manager at Aberdeen, to that of manager of the Dundee and District Exchanges, with nearly 700 subscribers, and branch exchanges at Broughty Ferry, Newport, Tayport, Forfar, and Perth, while others are to be formed at Arbroath and Montrose.

THE CREIL EXPERIMENTS.—These experiments, which were to have begun in January, have been delayed by the late hard frost, which prevented the erection of the posts for carrying the cable, and also rendered brittle the insulating substance with which the latter was to be covered, as a prudential measure. The machines have been erected under the supervision of M. Marcel Deprez, who is said to guard them with the greatest jealousy.

AT HOME OR NOT.—The story is well known of a country servant who told a caller that her mistress said she was not at home. They now manage these things better on the Continent by the aid of electricity. The visitor presents his card to the *concierge*, who telegraphs the name to the *locataire*, or occupier of the apartment, if he is within, and receives back a sign, only visible to himself, denoting whether he will "receive," or not be bothered.

"THE GENIUS OF PROGRESS."—This is the title of a painting by Herr Ludwig Kandler, who has incorporated the realistic and the allegorical in a beautiful female figure with incandescent lamps set as a coronet on her brow, holding aloft in her right hand an arc light as beacon, with the battery in her left, while two attendant cherubs are holding discourse by means of the telephone. The picture is admirably reproduced in this week's *Sporting and Dramatic News*.

ELECTRIC LIGHT FOR HACKNEY.—Several of the larger tradesmen in Hackney are anxious to light their premises by electric lamps, to be supplied by the Jarman Company, whose works are at Homerton. Permission has been applied for to lay pipes from the factory to Mare-street; and the Board of Works has referred the subject to a committee. The Jarman Company has lighted some works at Glasgow, and also the Atlantic Wharf, while it is preparing the plant for lighting the town of Deal.

"THE "AQUIDABAN."—The electric lighting apparatus for the Brazilian ironclad "Aquidaban," which has been recently launched from Messrs. Samuda's yard, is to consist of three sets of direct-driven steam dynamos. Each set is composed of a new pattern Crompton dynamo, driven by a Willans high-speed compound three-cylinder engine. There are to be 250 incandescent lights fitted all over the ship, in addition to two projectors for search-light purposes. The whole of the work is being carried out by Messrs. R. E. Crompton and Co.

AN ELECTRICAL TRAMCAR.—At the Wandsworth Board of Works the following motion has been made with regard to the proposed running of an electrical tramcar:—"That before the consent of the Board be given to the proposal to run electric cars on the tramways, the opinion of an independent engineer or expert be taken, and that the engineer engaged do attend the General Purposes Committee on their visit to inspect the said cars, the fee and expenses of the engineer not to exceed the sum of £10 10s., and such fee and expenses to be paid to this Board by the parties making the application."

HARROW.—The lighting of the Harrow School laundry, which had for some time been carried out by means of two A Gramme machines and Serrin lamps, has recently been entirely changed. The old installation has been completely removed, and a new one put up by Messrs. R. E. Crompton

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and Co., consisting of a Crompton-Bürgin machine and incandescent lamps. We understand that the masters, and all connected with the laundry, are very much pleased with the new lighting, and the work as carried out is a credit to the contractors.

NEW COMPANY.—The Compagnie de Signaux Magnétiques et Communications Téléphoniques has been founded at Paris, with a capital of 1,250,000f. (£50,000), in 2,500 shares of 500f. (£20) each for exploiting, in all countries of the world, magnetic signals and telephonic communications, especially the patent of Bruno Abdank Abakanowics. The promoters are M. Adrien Hebrard and M. Cornélius Herz, who each received 100 paid-up shares. The above named, with M. Marcel Bernstein, M. Amédée Bocher, and M. Emile Leclert, form the council of administration—that is to say, the board of directors.

PRIZE FOR TREATISE ON THE DYNAMO.—The Real Academia de Ciencias exactas, fisicas y naturales of Madrid offers prizes consisting of gold medals weighing 60 grammes (nearly 2oz.), besides *accessits* and hon. mentions, for the best paper on three subjects, including one on the mathematical theory of magneto-electric and dynamo-electric machines, especially those based upon the Gramme machine, including induction and practical applications. Papers for competition are to be sent in by 31st December, 1866; and foreigners as well as natives of Spain are admitted to compete, members of the Academy being alone excepted.

LONG-DISTANCE TELEPHONY IN FRANCE.—The *Journal Officiel* of the French Republic has notified that from 16th January long-distance telephone communication has been afforded between Rouen and Havre by means of the telegraph wires connecting the two cities. The fee is 1f. for five minutes' conversation; and communications may be made between public call offices in the waiting rooms and post-office at Rouen and the central telegraph office at Havre. Other call offices are to be opened shortly; and telephone subscribers may hold converse from their own houses, on the same terms, as soon as certain modifications have been made in their instruments.

ELECTRIC LIGHT IN PARIS.—Among the few electric lighting installations which have been preserved in the public thoroughfares of Paris, that of the Place du Carrousel is among the most noteworthy. Ten tall candelabra, curved at the top, carry pulleys on which work the cords for suspending the Lontin lamps. Both the cords and the conductors are wound on a winch for raising the lamps to a height of eight metres, or 26ft. Two other lamps, on the Mersanne principle, with horizontal carbons, are mounted on a central column at a height of 20 metres, or 65ft. All the lamps are provided with reflectors, which throw the rays downwards. The dynamos, driven by a 35 horse-power steam engine, are placed in a temporary pavilion.

THE TELEPHONE IN A TUNIS SHRINE.—*The Times* Paris correspondent has sent the "Thunderer" an amusing account of the application of the telephone to a Kouba, or shrine, in the environs of the holy city Kairwan, the keeper of which is of French origin and a seceder from the Roman faith. His revenues being small, it struck him that a telephone might render him real service, so he decided to instal one in the Kouba, which will convey to him in his chamber the questions put to the saint, and return his own replies. Besides the material advantages which this mode of performing his ministry might bring him, he knows that he will produce a deep and salutary impression on the minds of the faithful, for whom the *modus operandi* will long remain a dread mystery.

ITALIAN TELEGRAPHS.—It appears from an official return by Cavaliere E. D'Amico, director-general of telegraphs in Italy, that in 1883 the total length of the lines was 28,506 kilometres (17,712 miles), with 97,136 kilometres (60,358 miles) of wire, showing an increase, as compared with 1882, of 893 kilometres (555 miles) of line and 3,417 kilometres (2,122 miles) of wire. During 1883, 147 new offices were opened, bringing up the number to 2,737, with 2,932 instruments. The number of telegrams, inland and foreign, was 7,176,523, showing an increase of 124,302 over that of the preceding year. The receipts amounted to 10,971,741 lire (£438,869), and the expenses to 9,190,433 lire (£367,617), giving a net profit of 1,781,308 lire (£71,252), while the Government messages were sent free of charge.

ELECTRICAL STORAGE.—Mr. Eric Bruce, in his lectures upon the electric light, says that, for private house lighting purposes, the storage of energy is almost indispensable. If a dynamo machine only is used, the lights could only be maintained when the machine is working; but, if the energy could be stored, the lights would be available at any time. Many persons now used the electric light in their houses, and even in bed rooms as a night light which they could turn on and off at any time, simply because they had an accumulator. He had used an accumulator four or five weeks, during which time it was only charged twice or thrice, and there was not a single breakdown. The lecturer explained by means of experiments the construction and working of a storage battery, and illustrated the principle by burning portions of magnesium wire.

THE SS. "TAINUI."—This fine ship, built by Messrs. Denny Brothers, of Dumbarton, for Messrs. Shaw, Saville, and Albion, has been fitted with 306 Swan 20-candle lamps, fed from two Ferranti-Thompson dynamos, excited by two Siemens machines, all driven by an engine from Marshall and Sons, Gainsborough. The specification for the installation was drawn up by Professor Jamieson, of Glasgow; and the work was executed under the superintendence of Mr. R. D. Smillie, M.S.T.E., the chief electrician of Messrs. Denny Brothers, who have now an electrical department in their works. The insulation resistance of the circuit is far above the average; and great care has been taken to guard the wires from injury. The ship is wired on the system which employs the hull as a return wire. Safety fuses of "mica-foil" are inserted in every main and branch circuit.

EXPERIMENTS ON LIGHT SHIPS.—We learn that Messrs. R. E. Crompton and Co. are carrying out experiments, under the direction of Captain Graham Hills, R.N., of the Mersey Harbour Board, to test the suitability of the electric light for use on board the light ships. The set of plant for each light ship will consist of a Crompton-Bürgin dynamo, driven direct by a Willans engine, supplying current to two powerful arc lights of 4,000 candle-power each. The lamps themselves will be of the ordinary Crompton-Crabb pattern, and be fixed in the large lanterns at present in use. The beam will be diffused equally in all directions without any attempt to concentrate it by means of diaptric appliances. The whole of the generating plant is contained in a small deck house, and can be managed by the ordinary lightship keepers.

THE TELEPHONE AT STOCKPORT.—In accordance with the terms of the new license granted to telephone companies by the Postmaster-General, the Lancashire and Cheshire Telephone Exchange Company is making arrangements for the opening of

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call offices, in which the public may speak to a subscriber for 3d. for three minutes in the same town, or 6d. between two towns. On wishing to speak with a subscriber, a person enters the central or a branch office, and, if the latter, he drops his 3d. or 6d. into a box which communicates automatically with the central office. The name of the person to which he wishes to speak is made known to the official at the central office, who immediately puts the parties into direct communication with each other. The automatic arrangement is such that the official knows at once whether 3d. or 6d. has been put into the box, and can thus cut off communication at the proper time.

ELECTRIC LIGHTING IN THE NAVY.—Some experiments are being made on board the "Colossus" at Portsmouth, for the purpose of ascertaining the cost of electric lighting as compared with oil, &c. A certain number of lamps are kept on from 6 to 9 p.m., when the men's lights are turned out; but the officers' are continued till 11 p.m., in the same proportion as would be observed were the ship in service. From 1 p.m. to 7 a.m. the engine and boiler rooms are to remain lighted, as well as the passages and platform and other portions of the ship guarded by the ship's police. The Brush incandescent system is adopted, maintained by three Victoria dynamos, each one capable of generating sufficient current to light the whole ship, and leaving the other two available for the search lights. Each machine is perfectly interchangeable, and the whole plant is placed well below the water line, being protected by three inches of armour. There are 380 lamps, nearly half of 20 candle-power, and the remainder 10 candle-power.

MARYLEBONE AND THE RATING OF TELEPHONE COMPANIES.—The Court of Appeal last month gave judgment in the matter of the Lancashire and Cheshire Telephone Company and the overseers of Manchester. The judgment was that "everything connected with the working of the telephones was the exclusive property of the company, for whose benefit alone they were fixed; therefore the company was rateable, and the appeal must be dismissed," and was dismissed accordingly. The chairman of the United Committee of Marylebone, St. George's, Hanover-square, and St. James, seeing this judgment, put the following questions to the overseers of Manchester, to which he received the answers appended:—1. Did the overseers, in making their assessment for Manchester, assess a certain sum on every wire belonging to the company?—No. 2. Or did they put the whole of the estimated value of the wires as one property into one sum and assess the rate on the gross value?—Yes. 3. Or did they fix a nominal rate simply to bring the company within the claimed liability to the rate?—A moderate sum of £2,000 per annum. 4. If each wire were assessed separately, or the whole were assessed in one sum at the ordinary rate upon the estimated value, how was this value ascertained?—See above. 5. In all the wires in or elevated over the streets and thoroughfares of your city, by what means do you know to whom each wire belongs, so as to assess the proper parties for the same?—Practically all are owned by the same company. Notice of appeal to the House of Lords has been given.

MONTEFIORE ELECTRICAL INSTITUTE.—M. Montefiore-Levi, Belgian Senator and head of the works at Brussels where his phosphor-bronze is produced, has taken the lead in founding an electro-technical institute annexed to the Liége University, at the same time contributing a sum of 100,000f. (£4,000) for the purchase of instruments, &c. The object of this institute, like that of the Hammond Electrical College, is to provide means for engineers, on their leaving other schools, to acquire the special knowledge which shall fit them for practice as engineer-electricians. The lectures and workshop practice are so arranged as to constitute the programme of a supplementary year of study. This comprises four courses, one on the theory of electricity and magnetism, a second on mechanical construction, a third on the transmission of signals, and a fourth on electric lighting. A two-year complete course of study for the section of electricians includes the above four courses, and in addition applied mechanics, the construction of engines, physics applied to industry, metallurgy, railways, architecture, and languages. In both sections, practical work is made more prominent than theoretical teaching, the pupils being taught to use the cold-chisel and file as well as the principles of constructive mechanism. After passing two or three months in the workshop under the direction of a skilful mechanician, they go into the laboratory, then undertake industrial experiments, and are afterwards called upon to make an independent investigation into some specific subject. For further information, application should be made to M. Trasenster, Rector of the Liége University, Belgium, who so cordially received the members of the Institution of Mechanical Engineers on their visit to Liége in 1883.

THE TELEPHONE IN PARIS.—The General Telephone Company possesses a central office, corresponding with twelve branches scattered over the city; and, with few exceptions, the communications which pass by the district office to the central, and thence to the person called, are obtained in from thirty to forty seconds, any additional delay being caused by the correspondent not replying at once. According to the most recent statistics, the number of subscribers in Paris is about 3,700, of whom 3,550 already have communication, and 150 are on the point of receiving it. The average number of calls during the winter months is 24,000 a day and 1,000 a night from 7 in the evening to 8 in the morning, which gives an average of seven calls a day per subscriber. As the subscription is 600fr. (£24) per annum, or 2fr. (1s. 7d.) for each working day, a call costs on an average 28½c. (2¾d.). No telegram is so cheap or convenient as this; and the time taken for the delivery of a telegram averages an hour, whereas communication through the telephone is almost instantaneous. The company's double wires are more than 5,000 kilometres (3,106 miles) in length, the double wire system, introduced a year ago, being one of the greatest improvements which the company has effected. Great inconvenience has been felt from induction; but at present the double wire system has been most successful. The company considers that the rent paid to the City for the use of the sewers and the 10 per cent of the gross receipts paid to the State amount to about 25 per cent. of its earnings. The 220 persons employed receive salaries averaging 150f. and 160f. (£6 and £6 8s.) a month, lunch being provided gratis. At the "call" offices, though only opened a month, there has been an average of sixty communications a day.

SPAGNOLETTI TO THE TELEGRAPH ENGINEERS.—At the ordinary general meeting of the Society of Telegraphic Engineers and Electricians, held on 22nd ult., Mr. C. E. Spagnoletti, C.E., president of 1885, delivered his inaugural address. He referred with pleasure to the increased importance of the society, urged students to take greater part in the proceedings, pointed out the advantage of the library, and hoped that a laboratory would soon be added. Having premised that he was chiefly connected with railway telegraphy, Mr. Spagnoletti only touched lightly on other electrical subjects, remarking, however, on the work afforded women by the manufacture of incandescent lamps; the present dull state of affairs he attributed to the first rush and a desire to show what it was pos-

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sible to accomplish in electric lighting; the Act of 1872 was not altogether unsatisfactory, but some provisions must be modified. A good current meter was much wanted; and in the mean time charge must be made per light. The incandescent system was wholly unsuited to out-door lighting. Train lighting was an important branch, but beset with many difficulties; and electric lighting generally would not be carried out satisfactorily without accumulators. Great advance had been made in telegraphy; and it was fortunate that all the telegraphs of the kingdom were in the hands of Government, the promised reduction being likely to cause a great extension. No less than 26,000 miles of wire had been added on the railways. The use of sounders, a development of Sir Charles Bright's bell instrument, was increasing. In the Colonies the use of the quaduplex instrument was becoming greatly extended, while in the United States the English system of fast-speed working was being adopted. Though telephony progressed but slowly in this country, the line between London and Brighton showed the practicability of speaking for long distances. In London no less than 50,000 oral communications were made daily. The total length of wire in the United Kingdom was 9,000 miles, wth 7,000 instruments and 20 exchanges. The present high rental was excessive; and the Belgian system of charging a fixed sum for a conversation would be appreciated. The Van Rysselberghe system of long-distance telephony conld only be applied on a limited scale. M. Marcel Deprez' method of transmitting power had not yet given any practical result; but the telpherage system was making progress, though the carriage of goods by cars worked by accumulators was likely to prove a formidable competitor. Railway telegraphs for regulating traffic were being improved and appreciated; the use of electrical repeaters, tell tales, and locking gear was now becoming general; and a tablet system on the principle of the staff method of working was being introduced.

THE ELECTRIC LIGHT AT BERECHURCH HALL.—Mr. Octavius E. Coope writes as follows to *The Times*:—"Sir: Another year has passed since you so kindly found space in *The Times* for my last letter (vide *The Electrician*, Vol. XII., p. 269), with reference to my experience of the electrical lighting at Berechurch Hall. So many inquiries are still made to me personally that I cannot help being of opinion that a very short account of the last twelve months' working might perhaps be of even more interest to the public than the accounts I gave in my letters that appeared in *The Times* in January, 1883, and January, 1884, for the element of time has been coming into operation, and the unforeseen should have been making itself apparent. Briefly, then, the result of the last year's working has been to confirm the statements and conclusions I gave in my previous letters. The lights have given even more satisfaction, if possible. The whole of the machinery and conductors are working as well as when they were first put down. The expense is about the same as the previous year, being rather under that I should have had to pay for gas; and the light is so charming, convenient, and healthy, that after being accustomed to it one is indisposed to sit in a room lighted in any other manner. How it is that the electric light has not made greater progress in this country fills me with amazement; whereas in America the impetus has been enormous, especially with regard to arc lighting. In Montreal, Philadelphia, Buffalo, Cleveland, Chicago, St. Louis, Indianapolis, Boston, and New York, not only the principal streets but the warehouses, stores, and places of public resort are described as being brilliantly lighted by electricity. Of the Brush system only there are said to be upwards of 25,000 arc lamps in operation in the United S tates; and in New York the Edison central station alone supplies current for over 12,000 incandescent lights and yet cannot come up to the demand; and it intended to open two more central stations of much larger size. So far as our own towns are concerned, the almost entire absence of the electric light I think may be explainable, but as to country houses the case is different. With regard to these latter, is it that the owners imagine by delaying they will be able to take advantage of some great discovery and get the electric light for a tithe of what they would now have to pay? Let me assure them of this, that if I had to light Berechurch Hall afresh to-morrow I would have the installation laid out again in exactly the same manner; and the cost would be almost as much as in the spring of 1882. And, again, I am just as able to take advantage of any great improvement—which to my mind will come in the form of more economical incandescent lamps or more perfect accumulators—as those who are having an installation laid down to-day. With regard to accumulators, there has been within the last year a marked improvement, and I trust before long I may see my way to use them. As to incandescent lamps, I find that the life of the ones I use (the Swan) is continually lengthening; there is, however, a new incandescent lamp in the market, one that is said to give out as much light as those I have and requires but three-quarters of the current; so I am about to give them a rigorous trial, and if I find the statements correct adopt them, for it will enable me to put up over fifty fresh lights in various buildings and run them without any addition to my machinery or increase of cost in my annual working expenses, except, of course, for lamp renewals. To revert to our towns, there appears to have been a certain amount of friction between the electric light companies and the Board of Trade. This is radically wrong, and I can see no reason why it should not be completely overcome. It is possible that there may have been faults on both sides; but it is obvious that such grand-motherly legislation as clause 27 in the Electric Lighting Act must injure private enterprise and prove detrimental to the interests of the public. By the 27th clause every public installation is practically confiscated to the local authorities after twenty-one years, should they desire to possess it, which they assuredly would do if it were paying anything like a dividend; if it were not, they have only to wait a few years until it is a success and then claim it as their property, the amount they have to pay being a mere nominal one compared to the original cost of the installation. Anything more harsh or more unjust to a new industry it is impossible to conceive. Any clause framed with the deliberate intention of preventing capital being embarked could not possibly have been more ingeniously drawn up. This modern tendency to place legislative restrictions on new enterprises to such an extent as to almost throttle them is to me perfectly incomprehensible, and to my mind entirely opposed to all that has made England foremost in the world. So succcessful has it been with the telephone that, instead of now being in the hands of even the poorest artisan, it can only be used by the few who can afford to pay an exorbitant annual sum for the privilege. If the same principles had been in vogue with regard to railways and gas, we should still be travelling in coaches in streets lighted by oil lamps. Perhaps I may again be allowed to repeat that I am entirely unconnected with any electrical company or interest of any kind whatsoever, either directly or indirectly. My sole object has been to try and work out for myself the question as to the applicability of electricity for domestic uses, which I have succeeded in doing to my entire satisfaction; and I now have the pleasure for the third time of giving the result of my experience to the public through your kind courtesy."

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ALTERNATING CURRENTS.—MUTUAL-INDUCTION. GRAPHIC REPRESENTATION.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 200.)

MISPRINT.—In *The Electrician*, No. 10, Vol. XIV., January 17, 1885, "Alternating Currents," p. 199, column 2, line 34, for "converging" read "conveying."

For the sake of brevity it will be well to describe a magnitude undergoing harmonic variation by its maximum value. Thus, suppose in Fig. 1 B D, the projection of a constant line, A B, upon the axis of y, to represent the electromotive force at some instant acting through a circuit, and that the electromotive force undergoes the variations which this projection undergoes, it will be convenient to describe the electromotive force by its maximum value A B.

And similarly with currents. If a current is represented always by the projection of the magnitude representing its maximum, we may talk of the maximum value as the current.

Language based upon this convenient mode of expression has, in fact, been used towards the close of the previous article. We may employ the first proposition there given to the determination of the reading of a dynamometer subjected to alternating currents.

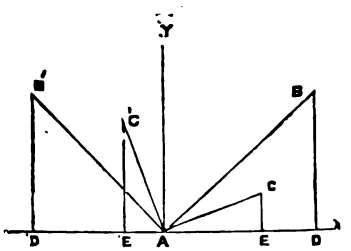

FIG. 1

Suppose, in Fig. 1, that A B represents the current through one of the coils of the dynamometer, and that A C represents the current through the other coil. Then the average value of the product of these currents will be $\frac{A C \, A B}{2} \cos B A C$.

But it is the average value of the product of these currents which will be proportional to the reading of the instrument.

Moreover, in an ordinary case the currents in the two coils are identical in value and coincident in phase.

The first consideration requires A B to be equal to A C, and we may take c as the value of each of them. The second consideration requires cos B A C to be equal to unity, since B A C = 0.

Therefore, the reading of the dynamometer will be proportional to $\frac{c^2}{2}$.

Thus the reading of the instrument which is produced by an alternating current c (*i.e.*, whose maximum is c) will be produced by a uniform current whose value is $\frac{c}{\sqrt{2}}$ or ·707 c.

The method of compounding the electromotive forces acting in one circuit and having the same period, but differing in phase, after the manner of forces and velocities in mechanics, is evidently true when we consider that the real electromotive force is the sum of the projections of each, individually projected, upon one straight line.

The graphic diagram resulting from the application of this method may be advantageously employed in exhibiting the effects of an alternating E.M.F. acting on a circuit possessing, besides self-induction, mutual induction on and from another circuit possessing self-induction in its turn.

Let L be the self-induction coefficient of the primary circuit.

Let L′ be the self-induction coefficient of the secondary circuit.

Let R and r be the resistances respectively of these two circuits, and

M the coefficient of mutual induction between them.

Take a line C F of magnitude h and draw C E at right angles to C F, and in magnitude equal to $\frac{M\pi}{RT}h$, so that, in fact, $\frac{M\pi}{RT} = \tan C F E$. On C E as diameter describe a semi-circle on the side remote from C F, and set off the angle E C A, whose tangent is equal to $\frac{L'\pi}{rT}$. From F draw F B perpendicular to A C produced, and produce B F towards F to G, so that $F G = \frac{M\pi}{rT} A C$. In C E take C D, so that C D bears to C E the same proportion which L bears to M. Join D G, and call it e.

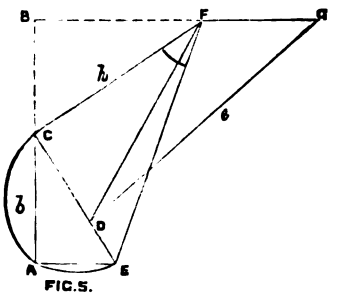

FIG. 5.

Then if e is the impressed electromotive force in the primary circuit, in phase and magnitude, C F or h will be the effective electromotive force in the primary circuit, and C A, which call f, the effective electromotive force in the secondary circuit, in phase and magnitude. In other words, dynamometers inserted in these two circuits will give the same reading as if the *constant* E.M.F.'s $\frac{h}{\sqrt{2}}$ and $\frac{f}{\sqrt{2}}$ were inserted in the circuits respectively, the angles of torsion being proportional to the squares of these lines C F A C respectively.

If we write

$$\tan\alpha = \frac{L\pi}{RT},$$

$$\tan\beta = \frac{L'\pi}{rT},$$

$$\tan\gamma = \frac{M\pi}{rT},$$

$$\tan\delta = \frac{M\pi}{RT},$$

then C F D = α, A C E = β, C F E = δ, and from the geometry of the figure we have

$$\left.\begin{aligned} f &= h\cos\beta\tan\delta \\ e^2 &= f^2\tan^2\gamma + \frac{h^2}{\cos^2\alpha} + 2fh\frac{\tan\gamma\cos\overline{\beta+\alpha}}{\cos\alpha} \end{aligned}\right\}.$$

Therefore we have for the equation connecting e and h

$$e^2 = \frac{h^2}{\cos^2\alpha}\{1 + \cos^2\alpha\cos^2\beta\tan^2\gamma\tan^2\delta + 2\cos\alpha\cos\beta\tan\gamma\tan\delta\cos\overline{\alpha+\beta}\},$$

and for the equation connecting e and f

$$e^2 = \frac{f^2}{\cos^2\alpha\cos^2\beta\tan^2\delta}\{1 + \cos^2\alpha\cos^2\beta\tan^2\gamma\tan^2\delta + 2\cos\alpha\cos\beta\tan\gamma\tan\delta\cos\overline{\alpha+\beta}\}.$$

If we write $\tan\phi$ for $\cos\alpha\cos\beta\tan\gamma\tan\delta$, for brevity's sake, these equations become :—

$$e^2 = \frac{h^2}{\cos^2\alpha\cos^2\phi}\{1 + \sin 2\phi\cos\overline{\alpha+\beta}\},$$

$$e^2 = \frac{f^2\tan^2\gamma}{\sin^2\phi}\{1 + \sin 2\phi\cos\overline{\alpha+\beta}\};$$

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or, to express the effective electromotive forces separately in terms of e,

$$h = \frac{e \cos \alpha \cos \phi}{\sqrt{1 + \sin 2\phi \cos \overline{\alpha + \beta}}},$$

$$f = \frac{e \sin \phi \cot \gamma}{\sqrt{1 + \sin 2\phi \cos \overline{\alpha + \beta}}},$$

whence the expressions for the currents $\frac{h}{R}$ and $\frac{f}{r}$, in terms of the coefficients of self and mutual induction, the resistances and the period, become, by the proper substitutions

$$\frac{h}{R} = \frac{e\,T\,(r^2\,T^2 + L'^2\,\pi^2)^{\frac{1}{2}}}{\{(M^2\,\pi^2 + R\,r\,T^2 - L\,L'\,\pi^2)^2 + \pi^2\,T^2\,(L\,r + L'\,R)^2\}^{\frac{1}{2}}} \cdot \quad (\alpha)$$

$$\frac{f}{r} = \frac{e\,T\,M\,\pi}{\{(M^2\,\pi^2 + R\,r\,T^2 - L\,L'\,\pi^2)^2 + \pi^2\,T^2\,(L\,r + L'\,R)^2\}^{\frac{1}{2}}} \cdot \quad (\beta)$$

The relation which the current in the secondary coil bears to that in the primary is simply

$$\frac{M\,\pi}{(r^2\,T^2 + L'^2\,\pi^2)^{\frac{1}{2}}} \cdot \cdot \cdot \cdot \cdot \cdot \cdot \quad (\gamma)$$

and the relation of the dynamometer readings in the two circuits will be as the square of this expression.

(TO BE CONTINUED.)

ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

At various times letters have appeared in the pages of *The Electrician* either asking for information how to construct a particular dynamo or setting forth unexpected difficulties or failures encountered by amateurs who tried to make small machines. Now, it would of course be very easy to compress into the space of a short article a few empirical rules which any amateur could faithfully follow, and thus construct a dynamo which will work more or less successfully. But this would hardly be satisfactory from a scientific point of view. It is not sufficient if we know how to make one particular kind of machine so that it will work; we must also know the why and wherefore of its performance, so as to be able to generalise from a few practical examples to all possible varieties of machines of the same kind. As regards dynamos, this knowledge is as yet very meagre. Let us at once confess that we cannot calculate with mathematical precision the best size, shape, and existing power of a pair of field-magnets, or the exact speed at which a given machine must run to produce a certain electrical output, unless we have previously made trials with similar magnets and machines. But worse than this, if we attempt a mathematical treatment on the basis of our standard text books, we are sometimes led to results utterly at variance with the outcome of practical experience. To cite only one case. According to Lenz, Jacobi, Dub, Müller, and others, the magnetic moment of cylindrical electro-magnets is for low exciting powers proportional to the exciting power, and also proportional to the square root of the diameter and to the square root of the third power of the length. The practical application of this law is simple enough; to obtain a maximum of magnetic moment with a minimum of iron and copper wire, it is best to make the magnets thin and long. This has actually been done in the original Edison machine, and after it was done and everybody had admired the beautiful application of a great scientific principle, Dr. Hopkinson doubled the output of the Edison machine by simply employing shorter and thicker magnets. In this case it would seem as if science had been positively misleading; but this was of course not so. It was not Dub's law which was at fault, but its application to a form of magnet for which its author had never intended it.

But although mathematical investigations have as yet not taught us how to design every detail of a dynamo with the same certainty of result as a civil engineer might design every strut and beam in an iron bridge, very good machines are daily being built by many dynamo makers in this country, who simply base their designs on experiments, assisted by mechanical instinct and a little, a very little, scientific calculation. For the rest, this is the course every new industry takes. The first makers of steam engines knew nothing of the mechanical theory of heat, and yet they made fairly good engines long before Joule, Clausius, Rankine, and Zeuner showed us how to make excellent engines. A similar improvement may be looked for in dynamos and motors; but until scientific men can show us the way we must be content to work and improve the machines as we are doing now, which, taking all things into consideration, is at a fairly good rate.

In the following a few simple rules are given for the design of dynamos, but in order not to fall into the error of mere rule of thumb practice it will be necessary to preface them by a few general considerations and principles on which such rules are based. So much has been written on the subject of dynamos and the principles which underlie their action, that many well-known things will have to be said here over again; but it is better to sin by repetition than to make the subject more difficult than it already is by omitting important first principles.

The interaction between an electric current and a magnet can most conveniently be considered by the conception of lines of force. Whether such lines do really exist or not does not concern us at present. For our purpose it suffices that by means of iron filings we can make such lines visible and study their properties. According to this conception every wire carrying a current is surrounded by a multitude of circular lines packed closely together in the immediate neighbourhood of the wire and more sparsely at a distance from it. If we could have a free magnet pole—that is, a piece of steel having only one polarity, say north, for instance—this pole would, if brought near the wire, revolve round it; but since a magnet with only one pole is an impossibility, and since the same force which urges the north pole in one direction will urge the south pole in the opposite direction, the magnet as a whole cannot revolve round the straight wire, but will set itself at right angles to it. Which way the lines of force run round the wire we cannot say, but to fix ideas we shall consider those lines positive which would carry a N pole round the wire in the direction of the hands of a watch if the observer sees the wire end on, and if the current flows from the observer. If we place a piece of paper over the magnet, and at right angles to the wire, the lines of force made visible by iron filings will now appear as somewhat distorted circles crowding densely into the poles of the magnet. Within the magnet they are not so well defined as outside it; but as near as can be judged from a rough experiment no lines are lost in the middle, and the same number of lines which enter at one side of the magnet find their way out at the other. This follows also from the consideration that we cannot have one free magnetic pole or a magnet with unequal poles. From this it will be seen that every line of force must be a closed line; an open magnetic line of force—that is a line with two ends—is as much an impossibility as a continuous current in an open circuit. According to our nomenclature, the positive line of force goes in air from N to S, and in iron from S to N. If, instead of a steel magnet, we had experimented with a piece of soft iron, we would also find that through its presence the originally circular lines round the wire have become somewhat distorted and crowded together at the ends of the piece of iron, which, like a steel magnet, will set itself at right angles to the straight wire. The total number of lines made visible by filings has been considerably increased, even on the side of the wire opposite to that where the piece of iron is placed; and if we increase the current we can still further increase the number of lines. This experiment, therefore, shows that the number of lines, other things being equal, depends on the strength of the current, and that one and the same current will yield more lines if a piece of soft iron be placed in its neighbourhood. It also shows that the lines pass more easily through iron than through air.

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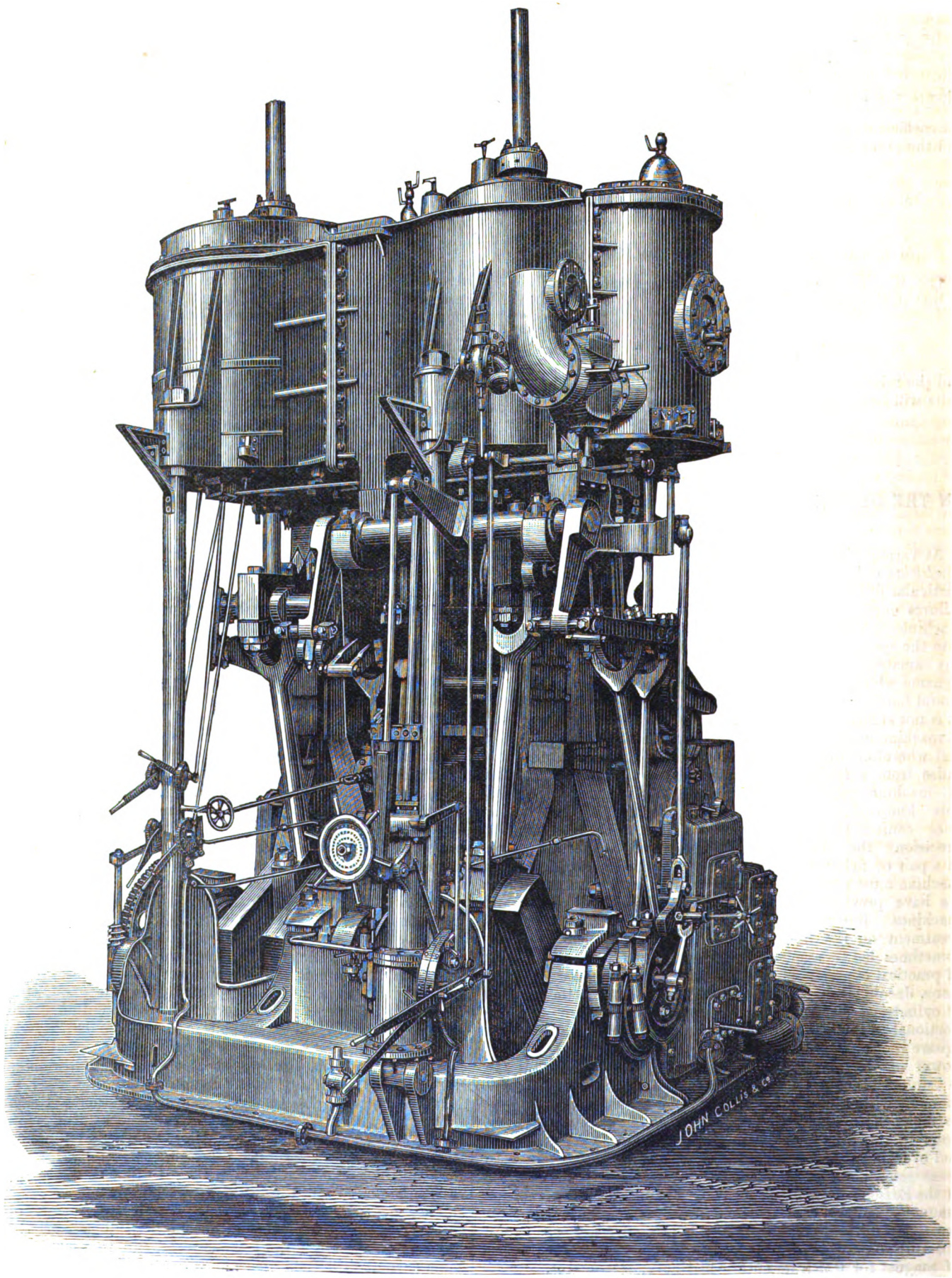
THE NEW STEAMSHIP "THE ELECTRA."



COMPOUND ENGINES OF THE ss. "ELECTRA."

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THE ss. "ELECTRA."

We this week illustrate the latest addition to our cable fleet. The ss. "Electra" was built by Messrs. Napier and Sons, of Glasgow, from the designs of Mr. Joseph Birnie, of the West India Graving Docks Company, for the Eastern Telegraph Company. In speaking of the sister vessel, described and illustrated in our issue of January 3rd, we referred to these vessels as splendid examples of the forethought and enterprise of our cable companies. They have been built and fitted throughout with the view to make them perfect for the work in which they are to be engaged. We may be permitted to lift the veil of cable management for once, and to strenuously assert that it is by no means a bed of roses. The breaking down of a cable is very different to the breaking down of a five-barred gate, and we may say that breakdowns are unfortunately by no means infrequent. They are not flaunted in the face of the public, as may well be imagined; in fact, except in cases where messages cannot be transmitted, are rarely known outside the offices of the companies. Duplicating and triplicating the lines doubles or trebles the chance of faults, but, at the same time, is one of the most effective methods of preserving uninterrupted the channel of communication. It rarely happens that the two or three alternative lines are down at once. Periodically the shareholders know the cost of maintaining their lines, but they cannot realise the anxieties of their officers under the uncertain incubus of not knowing what an hour may bring forth. Elsewhere we give a list of the Eastern Company's cables and connections, and we may say that it is not unknown to have from, say, four to eight breakdowns in the system at the same time. The problem to be decided by the management is no easy one, and may be said to be—to have sufficient *materiél* in ships, men, and appliances, so that all faults may be remedied with the least possible delay, yet, while achieving this very desirable work, to minimise the expenses. Well-found repairing vessels are then a costly necessity. The better they are adapted for their work the more economical to the shareholders.

The vessel we now illustrate is intended for the Mediterranean Station. It has the following dimensions:—

	ft.	in.
Length between perpendiculars	230	0
Beam (moulded)	32	0
Depth of hold, top of floors to top of maindeck beam	16	9
Depth, top of floors to top of awning deck	24	0

Tonnage B.M. about 1,096 tons.

The ship is to run 12½ knots on trial, and 11 knots when working with a consumption of 14 tons of coal per day; she carries coal for sixteen days' steaming. The ship is built wholly of steel except keel, stern, and rudder frame, which are of iron, and is fitted with water ballast tanks, as shown in the detailed drawings. There are four cable tanks; that forward is about 25ft. by 12ft., built on top of forward water ballast tank. The top of water ballast tank is ½in.; the sides of tank are ⅜in. in one length, plated vertically with double riveted external butt strips 9in. by 7-16in., the riveting perfectly flush inside. The bottom angles on top of water ballast tank are 3½in. by 3½in. by ½in., the top angles are double, 3in. by 3in. by 7-16in., inside and outside of tank, to receive the feet of pillars from girders under deck to top of tank. The inside angles have eye-bolts about 8ft. apart for life lines. The girders under main deck on top of cable tank are four in number, and extend from the engine room bulkhead to after end of fore hatch, fastened to beams by lugs, to which girders are to be riveted. These girders are 9in. by 7-16in., with double angles 3in. by 3in. by 7-16in. top and bottom. The cable tank is pillared from these girders with three pillars with feet top and bottom, riveted to tank angles and girders. The discharge valves on bottoms are supplied by Messrs. Johnson and Phillips to three out of the four tanks. Crinolines are fitted to Nos. 1, 2, and 3 tanks. The after tanks have bottoms ½in., sides ⅜in., and strips 7-16in., with angles similar to forward tank. The eyes of Nos. 1, 2, and 3 tanks are cone-shaped, tapering from 6ft. to 3ft. at top, with portable tops, and form fresh water tanks.

The main deck is plated with steel, according to Lloyd's rules, covered with 3½in. by 6in. pitch pine deck, in long lengths. Like the sister ship, this vessel is supplied with cylindrical condensers by Messrs. Starnes and Son; but we may for a moment interpolate among drier reading, and mention that every care has been taken for the comfort and convenience of the crew. The cabins are commodious, those of the chief, second, and third officers and electricians being deck cabins, plated in ends and sides with steel, the fittings and doors being of polished teak. The engineers' cabin and bath room, and the second and third engineers' cabins and mess rooms are—except lining—wholly of polished teak, and, as we say, in all cases there has been every effort made to secure good ventilation, comfort, and convenience. The saloon is of teak and maple, with circular panels, gilded capitals, and overhead moulding; the half pillars are of fluted walnut, gilded; the overhead of saloon is in flatted white, picked with gold on edges of mouldings; the chart house is framed of pine, with teak combings, the top clyde shaped with a teak deck; the inside fittings are of teak. We do not remember to have seen anywhere—and it may therefore be interesting to give—the fittings of a cable ship's workshop. The workshop of the "Electra" for the engineers is aft, fitted up in pine, lockers painted, grained and varnished, entrance from engine room through watertight door or from main decks. It contains, besides vice, bench, and lockers, the following tools, manufactured by James Mackenzie and Co.:—One gap lathe, 7in. centres, screw cutting, self acting, with change wheels, chuck plates, counter-shafts, &c.; one vertical double-geared 1¾ spindle, with revolving and elevating table, with fast and loose pulleys; one complete set of American twist drill, a continuous line of 2in. shafting (bright), with hangers and drums; engine fitted on to bulkhead capable of driving the whole tools, with copper steam pipes from main and donkey boilers, valves, &c.; cords and bands fitted to all machines; grindstone and trough, with fast and loose pulleys and band, spanners and tools, all fitted into racks on sides of tank; a full and complete set of steel turning tools for wood and iron, with handles, two drawing boards, and two squares. The testing room is built on awning deck in line with the wheel house, wholly of teak. The inside of the room is lined with V match boarding of polished teak, the other fittings being of teak. The ship carries six boats—viz., two life-boats, 24ft.; two cutters, 18ft. and 20ft.; one gig, 25ft.; one dinghy, 12ft., all fitted with head and stern sheaves and back spars. The ventilation is by the steam system of Messrs. M'Whirter, Roberts, and Co., and may be thus briefly described:—A 10in. circular pipe is fixed on both sides of main deck, under the beams and over the scuttles, extending from officers' room 80ft. forward as far as fore-end of forecastle each side, connected with 16in. cowl heads; a 10in. circular pipe, fixed on both sides under main deck and below saloon, extending aft to engine room bulk head, also connected with a 16in. cowl head, and holes 16in. × 4in. are cut close to ship's sides through decks in all cabins, which are connected with pilasters to the same with an internal diameter of 6in. by 4in., reaching to a height of 6ft., and ending with a 6in. ordinary brass cabin door ventilator. Ventilators are also fitted on awning deck for downcast, and two 10in. pipes are fitted on both sides under forecastle, with ventilators carried to upper deck.

The cable gear is similar to that in the "Magneta," and has been manufactured by Messrs. Johnson and Phillips, being of the best and most modern design and construction, consisting of bow guards and triple sheaves, davits, crosspiece, and three tackles, stopper hooks, and plummer blocks built into the bow of the ship; dynamos for both picking up and paying out gear and lead wheels; a double-combined picking-up and paying-out machine, with engines designed especially for the ship, with holding back gear for paying out and draw off gear for picking up. To insure rigidity and avoid pillars in between decks, fore and aft foundation plates are riveted to steel main deck, with well plates, double angles top and bottom, having a foundation plate and chocks fitted overhead between deck beams in way of holding down bolts. The main

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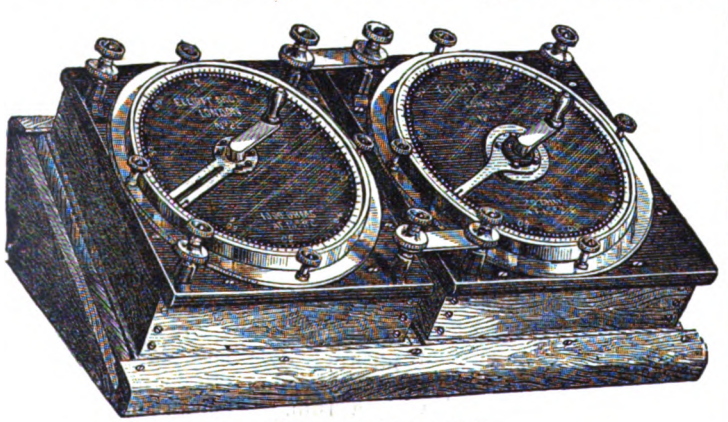
deck is carried right through between girders, and teak chocks between same. The cable gear is connected to main and donkey boiler, with copper pipes arranged not to cross the cable tanks, felted and covered with canvas and painted, with all stop valves and fittings. Of course it is to be expected that a modern vessel would be lighted by electricity, and we find that this ship is so lighted. Beside the incandescent lamps it has five arc lights and one powerful search light on bridge, with reflector. The lighting work has been carried out by Messrs. Johnson and Phillips, of Charlton.

Engines.

The engines of the "Electra," which we illustrate on p. 260, were built by Messrs. R. Napier and Sons, of Glasgow, and are similar to those of the "Magneta." They are of the compound, surface condensing, direct-acting type, fitted with all the latest improvements, and having two inverted cylinders 32in. and 64in. by 3ft. 6in. stroke. The crank, shaft, and piston rods are of steel. To facilitate the quick handling of the engines necessary in such a ship, Brown's latest improved reversing engine has been fitted, and besides the usual circulating pump there has also been fitted one of J. and H. Gwynne's centrifugal pumping engines for circulating water through the condensers and pumping from the bilges; also a special donkey, with an elaborate system of pipes for pumping from the cable and ballast tanks. Steam is supplied to the engines by two single-ended cylindrical steel boilers, with three of Fox's corrugated furnaces in each, and fitted with Galley's patent firebars. The engines are capable of developing 1,400 indicated horse-power, and of driving the ship at a speed of 12½ knots.

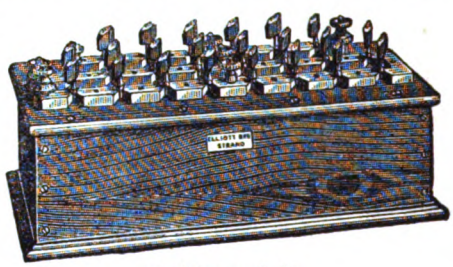
Electrical Apparatus.

The instruments for the testing room are perhaps the most complete that will be found on any vessel afloat. By the courtesy of Messrs. Elliott Brothers, of 101, St. Martin's-lane, who have supplied the electrical apparatus, we have seen many of the instruments and much of the apparatus destined for



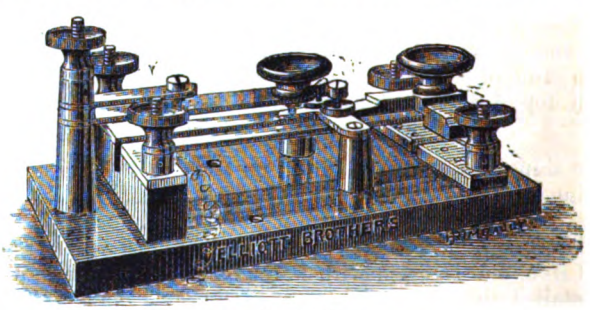
Sliding Resistance Coils.

the "Electra" before leaving the works. A brief reference to some of the chief instruments may be interesting:—*Large Marine Galvanometer.*—This instrument is an enlargement of the well-known form, the iron box being 6¼in. high and 6½in. diameter. The resistance of the bobbin is 30,000 ohms, and the constant from 40 to 50 megohms. *The Sliding Shunt* is a convenient form of shunt, with eleven multiplying powers, viz., 2, 3, 4, 5, 6, 7, 8, 9, 10, 100, 1,000, the changes being rapidly made by a sliding arm, as the name implies. *Platinum Silver Coil.*—This instrument is already well known; an extension of the bridge is, however, made, enabling readings to be taken from ·001 of an ohm to 10 megohms. *Sliding Coils.*—These coils are according to the arrangement of Sir W. Thomson, the resistances being varied by moving arms instead of plugs. They are made in pairs, one having 101 coils of 1,000 ohms each, and two contact arms embracing two coils, and the other 100 coils of 20 ohms each and one contact arm. The coils are used as the arms of the Wheatstone bridge. *Megohm.*—This resistance is divided into four sections of 250,000 ohms each, the coils being wound on about 40 bobbins, in order, as in the 250,000 coil, to equalise themselves to the temperature quickly. *250,000 ohms Coil.*—This coil is divided into six sections—viz., 10,000, 20,000, 20,000, 50,000, 50,000, and 100,000 ohms, the ends being taken to terminals mounted on ebonite pillars. The coils are wound on as many bobbins as possible, in order to get the temperature equally and quickly. *Saunders's Signalling Key* is a light working form of key introduced by Mr. Saunders, the levers of the key having spring extensions at the back for prolonging the contacts. This key was described fully and illustrated in *The Electrician*, Vol. VII, p. 309. *Subdivided Condenser.*—This has a total of one microfarad subdivided into five parts—viz., ·05, ·05, ·2, ·2, ·5. *Brass Case Galvanometer.*—This instrument is especially designed



Resistance Coils.

for use abroad and for ship service on account of its portability. It is a reflecting astatic galvanometer, with four coils of about 7,000 ohms resistance, mounted on ebonite base, with an outer cylindrical case 8in. high and 4¼in. diameter. It has a thermometer fixed to the outer case, so that the inner temperature can be readily taken. The lamp stand with the galvanometer is solid mahogany, dead blacked, with a slide for raising and lowering the scale, and a rack and pinion for a lateral motion, a convenience for bringing the zero of the scale to the spot of light. *Shunt Coils*, now used in place of the ordinary shunt, 1-9th, 1-99th, 1-999th. It has a total resistance of 10,000 ohms, subdivided in the usual manner, so that any resistance from 1 to 10,000 can be used as the shunt. *Speaking Galvanometer.*—This instrument is mounted on a solid mahogany base, the bobbin being wound in three sections, each connected



Lambert's Key.

to terminal on the base. The sensitiveness of the instrument may be increased or decreased by the use of these sections, which can be used either singly or in combination. Spare tubes with mirrors already suspended are supplied. *50 Portable Leclanchés in Box.*—A small, convenient form of Leclanché cell, each 3½in. long and 1¼in. square, packed in an oak case, the ends being taken to terminals fixed to either side of the case itself. Besides these the outfit includes *10 Leclanchés in Gutta Percha Pots.* The gutta percha pot replaces the glass jar, usually supplied for Leclanchés. It is a box 5in. high and 3¼in. square, with a hole in the top which supports and holds the porous pot. The cells are packed in teak trays, with solid india rubber blocks screwed to the sides and bottom. These blocks serve to take off blows or jars, and, in fact, act the part of buffer springs, as well as serving as additional insulation. *Speaking Marine Galvanometer.*—This instrument has been designed for speaking; it is a modification of the marine galvanometer, the iron box being replaced by a brass one which contains the bobbin, the whole being mounted on a solid brass

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pillar. It has a pair of compound magnets, which completely surround the bobbin, bringing the mirror quickly to zero; it has an adjustable air chamber for the mirror, the deflections being reduced to a dead beat. The adjustment of this instrument is such that no matter how great the motion of the ship the mirror remains stationary until the currents are sent through the coil. *Lambert's Key for Capacity Test.*—This key does away with four separate keys usually used. In taking this test it is really a combination of four keys well under hand upon one base. It is both simple in design and useful in testing. There are two condensers of 20 microfarads each, subdivided into four sections of 1, 2, 2, 5, 10 microfarads in solid teak box, as usually used in cable work. *The Small Tool Chest*, specially arranged for the convenience of everyday work, contains an assortment of files of all sizes, brace with sets of centre bits from ¼in. to 1¼in., saws, screws, &c. *Large Tool Chest.*—A much extended form of the above, and contains everything that can possibly be wanted in the work of repairing both in carpentry and metal work. *The Jointer's Box* contains all the requisites for the conveniences of jointing large spirit lamp and stand, smoothing

Galvanometer.

irons, and an ingenious clip for holding the cable ends while making a joint.

The Lighting Arrangements.

The ship is lighted, as we have said, with the electric light by means of 105 20-candle Edison-Swan lamps, in addition to which there is a powerful search light fixed on the bridge. The current is generated by four Gramme dynamos, driven by two separate Willans high speed engines. Three of these machines are devoted to the incandescent lighting, and the fourth machine furnishes the current for the search light. The engines and dynamos are fixed in a space specially prepared for them, adjoining the engine room. The wiring of the ship has received special attention, and highly insulated wires have been used throughout.

The Edison-Swan bayonet sockets for the lamps have been used throughout, and these are attached to suitable brackets. Between decks, over the tanks, &c., the lamps are protected by a wirework cover, while on deck the lamps are protected with a thick glass weather-proof cover. There are six lamps fixed over each cable tank, and the gear, the bulk of which is between decks, is also well lighted by several lamps fixed at suitable points, and protected from injury by wire cages. The circuits are divided into four distinct branches, each with its complement of lamps. They are all joined to an elaborate switch board consisting of several pairs of brass bars, one set of these bars being placed above, but at right angles to those beneath, to which they can be connected by means of a screw plug. By means of this arrangement it is possible to switch any one dynamo on to any of the four circuits, or on to more than one if it is desired to work more than one circuit by one dynamo. In fact, every possible change in the connections can be very easily made. Any dynamo or circuit can also be switched on to the ammeter or the voltmeter, and in addition to these instruments, by which careful measurements may at any moment be taken, there is in the dynamo room a pilot light from each circuit as a guide to the attendant in charge of the machines, the whole arrangement having been carried out by Messrs. Johnson and Phillips.

MATHER AND PLATT'S NEW DYNAMOS.

The dynamo is a modification of the original Gramme type, carried out on the same principle as Dr. John Hopkinson's reconstruction of the Edison dynamo. The mass of iron in the magnets and core of the armature is very largely increased, and the length of the magnetic circuit is shortened. The machine has a double magnetic circuit, which though slightly diminishing the efficiency of the machine greatly increases its compactness and symmetry of form. Figs. 1, 2, and 3 show respectively a plan, front elevation, and end elevation of

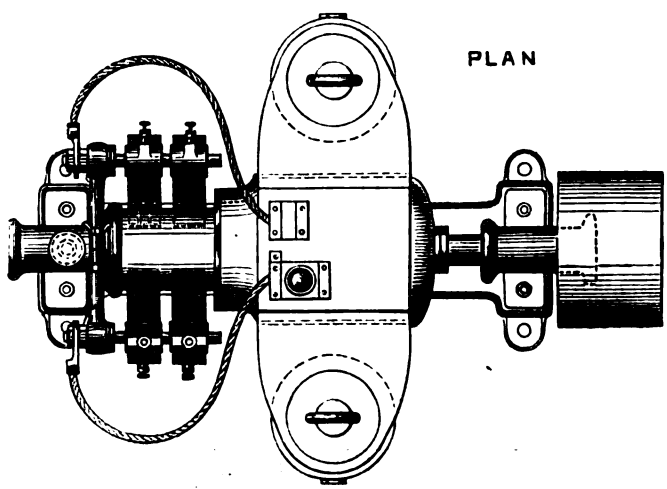

Fig. 1.

a 150 to 200 lamp machine, compound-wound, for 100 volts and 125 amperes, at 1,050 revolutions.

The shafts of the magnets are made of wrought iron, and let into cast-iron pole pieces, which have an increased section

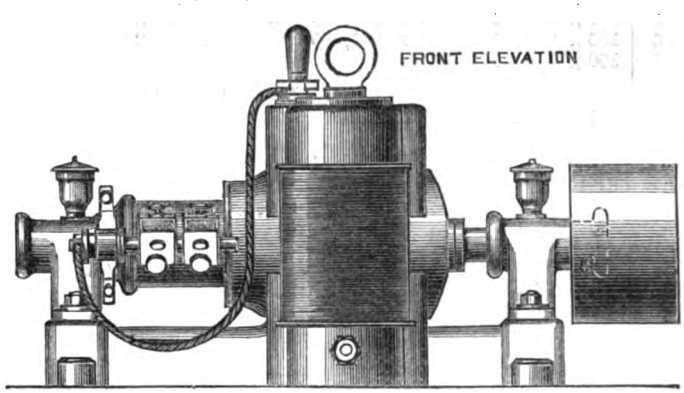

Fig. 2.

proportional to the lower magnetic permeability of cast iron over wrought iron. The lower pole piece is extended to form the bed of the machine, thus securing great compactness, keeping the centre of gravity of the moving parts as low as possible.

The armature of the machine has a free space left along the shaft to secure internal ventilation, and the commutators are large compared with the general dimensions, in order to diminish the sparking by giving as large a surface of contact

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as possible between the brushes and commutator bars. The commutators of all the machines have 40 bars of toughened brass and are insulated with mica.

In the machines for 100-lamps for high outputs there is a double brush on each rocking bar, capable of separate adjustment, with a spring forward thrust and butt contact. The machines are all compound wound for constant potential at the terminals, the series coils being external to the shunt coils. These changes in the Gramme machine have very largely increased its efficiency, so that the machines of the new type are not much inferior in efficiency to the Edison-Hopkinson machine, which has probably very nearly the highest efficiency attainable.

The perfect ventilation and low resistance of the armature enable these dynamos to carry a large load in proportion to

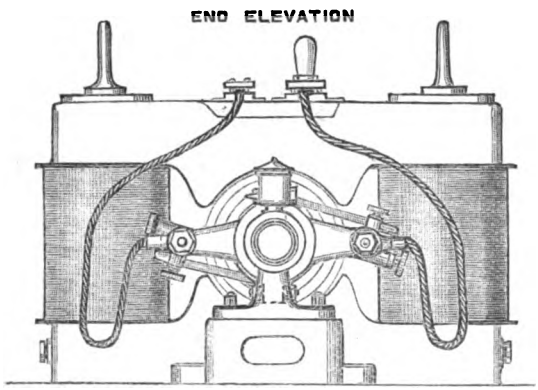

Fig. 3.

the size of the machine without heating. In fact, the load on the armature is determined by quite other considerations than that of heating.

Each machine is provided with a switch-board carried on the upper yoke, and fitted with a main plug switch and suitable terminals.

Messrs. Mather and Platt are at present manufacturing the following sizes :—

No.	No. of 20-c.p. lamps.	EMF. in volts.	Output in amps.	Speed.	Extreme dimensions. Length.	Height.	Breadth.	Size of Pulley.
					Ft. in.	Ft. in.	Ft. in.	
1	30 to 40	50	50	1,650	2 3	1 2	1 9	6×4
2	50 ,, 60	50	75	1,150	2 8	1 2	1 10	8×4½
3	100 ,, 130	100	80	1,100	3 4	1 6	2 4	10×6
4	150 ,, 200	100	120	1,050	3 6	1 7	2 6	12×8
5	300 ,, 340	100	220	850	4 3	1 10	3 2	14×9

The Telephone in Austria.—The Telephone Company of Austria has during the past year made great strides in the towns of Prague, Trieste, Gratz, Lemberg, Krakau, Czernowitz, Pilsen, Rickenberg, and Bielitz, for which the company holds exclusive concessions. In January, 1884, the number of subscribers was 436, which has now increased to 811 ; and it is expected that at least 400 additional paying subscribers will be connected up during the present year. The above will be of interest to the shareholders of the Consolidated Telephone Construction Company, as that company is a large holder of debentures and shares in the Telephone Company of Austria, and, moreover, manufactures all the instruments which are used in the Austrian exchanges.

Eastern Telegraph Company.—The *Standard's* correspondent at Rome wires that the telegraphic connection of Assab with the Suez and Aden cable of the Eastern Telegraph Company has been voted unanimously.

West Coast of America Telegraph Company.—The gross earnings of this company for the month ended January 31st amounted to £4,615.

NOTICES OF BOOKS.

A Pocket-book of Electrical Rules and Tables for the Use of Electricians and Engineers. By John Munro, C.E., and Andrew Jamieson, A.M.I.C.E. 2nd Edition, Revised. [Charles Griffin and Co., 1884.]

The march of events is too much for us, or rather we should say the intrinsic merits of this work are such that within twelve months two editions of it have been called for, and we understand a third is in preparation. We remember in years gone by in another place writing of another book which had obtained a brief popularity, that its deserts were better than its merits. The contrary is the case with the book before us in that it merits its deserts. Although the time between the issue of the first and second editions was very brief, a very large number of emendations were carried out, and we have no doubt others will be made in the forthcoming edition. Thus p. 2, "*Force* is that which produces motion, &c." This is only true in a strictly scientific sense, and when molecular motion is considered, we should prefer the ordinary definition. Again, p. 4, why is (N-seeking) pole specified ? But we venture to affirm that the value of the book lies not in its definitions ; and when the matter of practical value is considered it is excellent in quality and superabundant in quantity. There is one slight fault which might be amended, in that the authors seem to choose their authorities, naming some frequently, nay ostentatiously ; using others, but naming them infrequently ; giving contemporary publications in cases where their work is evidently nothing more than paste and scissors, and not mentioning them where the matter in question was contributed directly to their columns. The cable engineer will find this book a necessity. Never before has so much information been collected in so small a compass. He has here in handy form his formula, alternative methods, and diagrams of connections. Similarly, provision is made for the electric light engineer, the electro-metallurgist, the electro-chemist ; though perhaps not so completely. But Rome was not built in a day ; and if the second edition is better than the first, the third will be in advance of the second. And thus we go on towards perfection.

Magneto and Dynamo-Electric Machines, with Description of Electric Accumulators. From the German of Glaser de Cew. By F. Krohn, and specially edited, with many additions, by Paget Higgs, LL.D., D.Sc. [London : Symons and Co., 27, Bouverie-street, E.C. ; Edinburgh : Young Pentland, West Nicholson-street.]

It is now more than two years ago since we noticed the original of which the volume before us is a translation and extension. Almost all the best known machines are here described and illustrated, and in addition we have more or less complete accounts of Clausius's theory of the dynamo as well as the discussion of certain other theoretical questions. Although the book cannot be said to add anything to our knowledge of the subject, it seems to be a very good translation of the original work. The additions are certainly not the most unimportant part of the volume, although the theories therein given have been subjected to very severe and adverse criticism. We may say that this volume forms the first of a series which is called "The Specialists' Series."

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

In his lecture on the 1st ult., Professor Tyndall reminded his audience that in the preceding lecture he mentioned incidentally the action of atmospheric electricity, and he now, by the kindness of Sir James Paget, was enabled to show some garments which had been worn by a man who, during a thunderstorm, took refuge under a tree. This was a very dangerous proceeding. The tree was struck by lightning, as was also the man, on whose clothing it had an extraordinary effect. His clothes must, however, have been very wet when he was struck, for had they been dry he would certainly have been killed. It was the clothing and not the man's body which had conducted the electricity. Displaying a boot, the sole of which was a mass of hobnails,

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and which had evidently belonged to a "son of the soil," he said they must remember that the destructive effects of electricity were produced entirely where this wonderful power encountered resistance. So with this boot, they saw a part of it where the leather had been all torn; but in the sole the conductivity was good, and where the foot was on the ground the electricity passed harmlessly to earth. Resuming his lecture proper, Professor Tyndall called attention to what he dercribed as a beautiful machine, which they owed to Mr. Wimshurst, of the Board of Trade. It would, he said, take him some time to go through the philosophy of the machine, nor was he sure that he could do so. There was considerable difference of opinion about it. In 1777 a man named Bennett invented what he called the Doubler, to augment the strength of an extremely small amount of electricity. After him came a most ingenious electrician, Cavallo, and after him Nicholson, who published a very famous journal, and who invented another way of starting from an extremely small amount of electricity, so as to enhance its value and to make it a very large amount. That was briefly and vaguely explained by the principle of Wimshurst's machine, which they then saw before him, and which was so constructed as to show them a number of pleasant experiments. In the early days of electricity there was talk of crackling and fire produced by the friction of amber and sticks of sealing wax, and the machine would enable them to hear and see the crackling and the sparks. An interesting experiment was then given to show this. They had now (he continued) to dwell a moment on that subject of supreme importance which closed their last lecture—the Leyden jar, which was first described by a canon named Kleist. It was discovered a little time afterwards by Cunæus, of Leyden, and with great justice called after him the Leyden jar. Exhibiting a Leyden jar, and placing it on a cake or bed of resin, the lecturer said he would pour as much electricity as he could (experiment) into the interior of the jar, which was coated with tinfoil. The positive electricity acted through the glass on the outer coating. It attracted the negative electricity of the outer coating, and repelled the positive; but, the jar being insulated, the positive and negative existed side by side in the thin outer coating. When he connected the inner and the outer coating, they would get no discharge. [Experiment.] First of all, he cut the outer coating from all connection with the earth, then by means of a piece of wire in his hand he established a connection and the union of the electricities, when he put the coatings into contact and produced powerful sparks. A ball was next placed by his assistant in front of the lamp, and some bran was put under the ball. The image of the ball was then cast upon the screen, when the bran was seen leaping up to the ball, the lecturer explaining that instead of allowing the electricity which he had poured into the jar to escape through the wire to the earth he had let it go to the ball in front of the lamp. The question might have occurred to some clever boy present, Why do you waste the electricity of the outer coating by allowing it to flow to the earth? Why not send it into a second jar? Producing a second jar, he gave an experiment to illustrate this. He then poured electricity into the first jar, which was communicated to the second jar, and by means of the wire he communicated the electricity to the ball in front of the lamp, when, with the aid of the screen, the bran was seen to jump up as before towards the ball. He next placed a knob at the end of the arm of the prime conductor at some distance from the jar nearest to it, explaining that the knob was charged with electricity. The electricity was thus, without any contact, passed to the first jar, then to the second jar, and communicated through the wire to the ball in front of the lamp, and the bran beneath was again seen to be excited as before. The action in this experiment was not, he explained, due to direct electricity, but to the inductive action of the electricity. The experiment was carried out on the previous day at a greater distance from contact, but they had been enabled to do that owing to the fact that the air was not so moist as it was at that present moment. The Leyden jar was, he said, capable of all kinds of modifications; and he thought that no exercises could be better for a boy than making some of these modifications. He displayed a kind of jar which, he said, he devised some time ago. He had a piece of vulcanised india rubber. Clasping Mr. Cotterell's hand, he stated that his own hand was the interior coating of the Leyden jar, Mr. Cotterell's hand being the outer coating. [Experiment.] They had there a large battery, charged with electricity equivalent to fifteen Leyden jars. All the interior coatings were united together, and all the outside were connected with the earth. Producing a thin piece of silver wire, a weight was placed at each side of it. He then spanned from the knob of the prime conductor to the weight resting on one side of the wire, and sent the discharge through. The wire was reduced to a black powder. The prime conductor, he explained, was connected with the electric battery through the wire. They had heard him carefully warn Mr. Cotterell to keep clear of the arm of the machine, and he would tell them the reason for that. When he (the lecturer) was standing in that place some years ago addressing a similar audience, with a battery charged with equal force, his shoulder was struck by the arm of the machine. The result was absolutely nothing injurious to himself, but the wonder to him was that he had not fallen. He did not believe one member of the audience knew what had occurred, though they saw that something had happened. After standing a moment or two he seemed to open his eyes, though he supposed they had been open the whole of the time, and he saw a confused mass of apparatus before him. The optic nerve was so affected that he appeared to see himself in pieces, and it was some time before the retina assumed its normal condition. He would now pass from the region of frictional electricity into another region. He exhibited a large conductor, which was placed on two stands, and brought it into contact with the prime conductor. He explained that he brought this conductor for a special reason—because it was exactly the size of the conductor devised by Lord Mahon, to whose celebrated experiments on the return shock he referred. Near the large conductor, but not in contact with it, was a second one, from which a wire passed to the lecturer's hand. When the machine before them was worked the conductor was charged with positive electricity, and it would act on the adjacent conductor, driving the positive electricity through his body into the earth. Mr. Cotterell would take a spark from the knob at the end of the conductor. At each spark Mr. Cotterell took from the machine he (the lecturer) received a shock. There was a return of electricity into his body, and that was what Lord Mahon termed the return shock. In 1786 the celebrated Galvani was making experiments with a frog. It was well known before that electricity affected the limbs of dead frogs. That was not wonderful; but what was wonderful was this. Galvani was working in his laboratory with the limbs of these dead frogs. The limbs were at some distance from the conductor, and it was observed that every time a spark was taken from the conductor a quiver occurred in them. At that time the return shock had not been explained. They were now going to an entirely different region of electricity from that which occurred in Galvani's laboratory. Galvani took a frog, hung it to a railing outside his laboratory, and watched it throughout the day. In attaching the limb of his frog he had it placed on with a copper wire, and the rail was of iron, and when the frog's limbs came into contact with the iron Galvani noticed a quivering of the limbs. Exhibiting a plate of zinc, he said that the frog they saw was suspended by a piece of copper wire. This was the second discovery of Galvani which led to the great discovery of voltaic electricity. Volta, a great man, heard of Galvani's experiment, and first of all he disbelieved it, but he worked at the subject, and became convinced that Galvani was right! The lecturer now produced a pile, which he said was similar to the first made, and was the germ from which the electric light had grown. They had before them the voltaic pile, and they could see that the manner in which it was put together justified the term "pile." In the year 1800, in which Volta discovered or described the pile, Nicholson and Carlisle observed by accident that when the two ends of a wire from a voltaic pile were immersed in water bubbles were caused, and that one part consisted of oxygen and the other of hydrogen. [Experiment.] The wire was immersed in a small cell containing acidulated water, and the lecturer sent a current of electricity to either of these wires, and they saw on the screen that bubbles rose from the water. One voltaic cell was insufficient to overcome the attractive force, but the two should overcome the attraction. He had spoken of the atoms of oxygen and the atoms of hydrogen. They united so as to form a molecule. He had there a solution of a compound of lead —acetate of lead; and by sending a current through this solution they would decompose the solution, and on one of the wires would be the deposited lead. The minute particles of lead had the power of crystallising, and he showed by an experiment, with the aid of the screen, that they did not scatter themselves in a confused manner, but presented themselves in beautiful fern-like forms. Subsequently he gave illustrations of electro-plating, some copper plates being made to present the appearance of silver after the experiments. He next called attention to a great discovery by Sir Humphrey Davy with soda and potash, who produced a metal potassium. The affinity for potassium from oxygen was shown.

Danger of Constant Batteries.—Precautions should be taken with batteries in which polarisation is prevented by surrounding the electrode with nitric acid, giving rise to a reduction of the acid and a disengagement of nitrous vapours. Several cases of poisoning from such vapours are on record, notably at the hospitals of Bonn and Halle. A chemist who had worked for some considerable time in the fumes of nitric acid gradually became poisoned, and his recovery was slow, while a girl actually died twelve hours after carrying a vessel of nitric acid through the streets.

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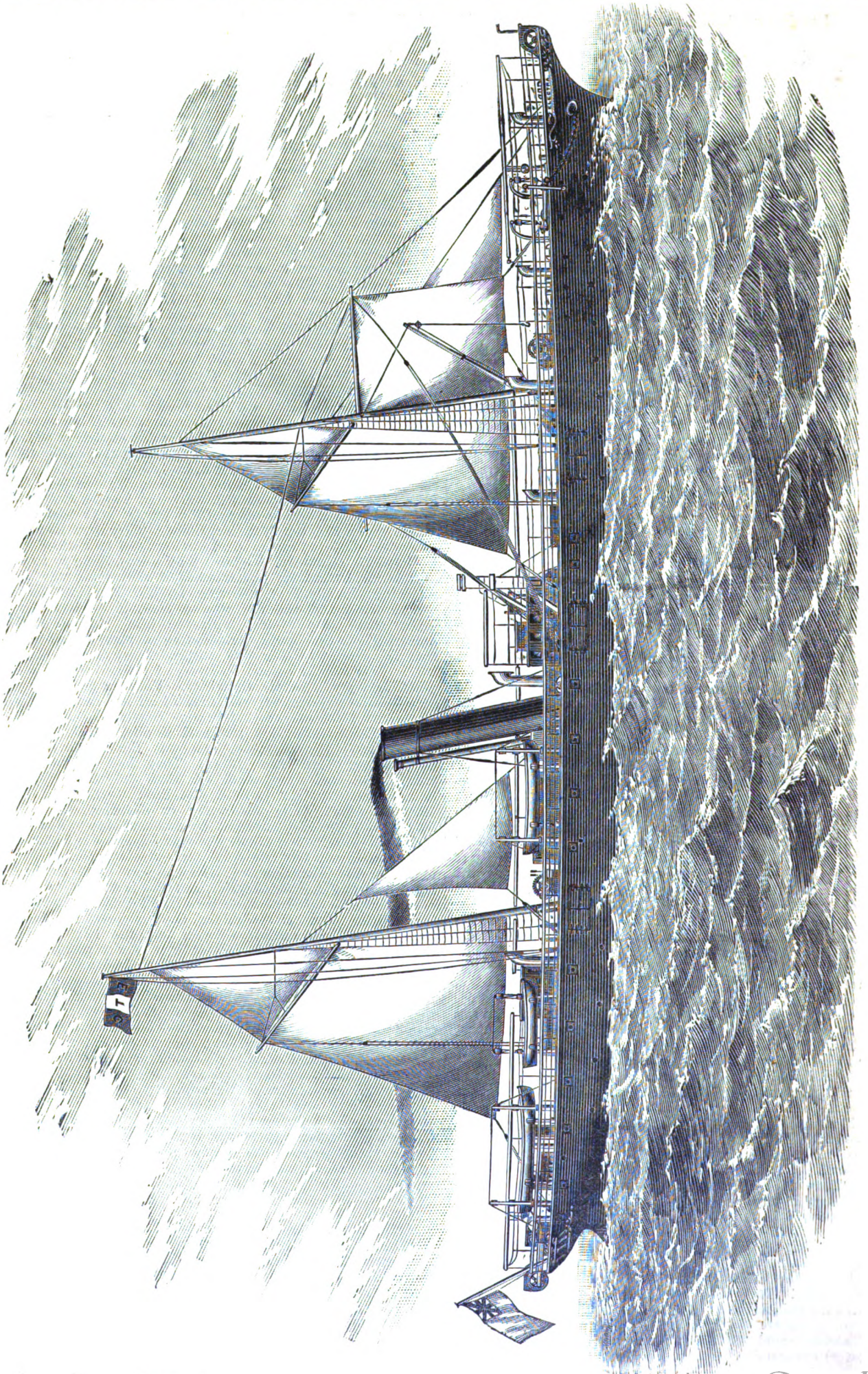

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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NOTICE.

A Special Supplement is issued with this week's number, showing details of the ss. "Electra." Information should be given at once to the Manager by any Subscriber whose copy is received without the Supplement—which is supplied Gratis.

TELEGRAPHS TO THE EAST.

Last week we had to comment upon the history and prospects of an electrical industry whose short career has been full of vicissitudes, and whose future prosperity is still a matter of uncertainty. To-day our attention is directed to another class of electrical enterprise whose success has never been doubtful from the first, whose growth, if it has been gradual, has never been interrupted, and whose future is as sure as any human undertaking can be said to be. About the success of electric lighting companies various untoward circumstances keep us still in doubt; if there ever was a doubt about the success of submarine telegraphy it is so long ago that we have forgotten it; and the report of a recent meeting of one of the largest submarine telegraph corporations, which we print in another column, shows that, by a wise combination of foresight and boldness, backed by good management, telegraph cables, although among the most fragile, are one of the most valuable of properties, and the business of working them one of the most lucrative.

In the face of disasters which have lately befallen some of the Atlantic cables our estimate may seem overcharged. But, in reality, they rather support our view. Without drawing invidious comparisons, which, indeed, we have no right to do, as the fault does not rest on the English side of the Atlantic, it must be apparent to all that the suicidal competition into which the several companies working between here and the United States have launched does not fulfil the conditions of success referred to above. Turning back at random to *The Electrician* of October, 1878, and looking at the market price of telegraph shares there quoted, and then comparing them with those given of the same month last year, we find that, with some insignificant exceptions, the companies working to the East, of which the EASTERN TELEGRAPH COMPANY seems to be the foremost, have nearly doubled, and in some instances more than doubled, the value of their shares. The same lists relating to the cables to the West show exactly opposite results, the depreciation being 50 per cent. or more. The bottom of the Atlantic indeed has been made the arena of financial speculation and reckless competition; no sooner has one cable been successful than another has been laid by a competitor; and, what is still worse, the laying of every fresh cable seems to be the signal for the others to mysteriously break down. Through no fault of their own the English companies to whom we owe our telegraphic communication with America have had to bear the brunt of a rivalry which conduces nothing to the public welfare, and has very much the appearance of being vindictive.

Happily from these forms of disaster the Eastern telegraphs have been almost entirely free; and what little of haphazard or speculative cable laying has occurred within the area covered by them has been wisely surrendered or absorbed so as to form duplicates of the larger systems, or alternative routes for cases of emergency. A large reserve fund has contributed to these results no doubt; but a bold and forward policy has done still more. Keeping touch of the commercial and political movements of the times, the companies have not only opened up new channels for trading communities, but have made themselves the indispensable ministers of imperial governments. The consequence is that the companies enjoy a practical monopoly which is financially remunerative to themselves and highly beneficial to Commerce and to States. Without it the mileage of cables might have been as great or greater; but the cohesion, the unity, and the organisation would have been wanting. Working from different points, and independently of each other, every breakdown would cause a stoppage of communication not only between those points but with them; connect them by friendly links and the whole forms one complete system which, as Mr. PENDER stated at the half-yearly meeting of the EASTERN COMPANY last week, enabled them to dispose of a good deal of extra traffic without any delay, although several of their cables had almost simultaneously gone amiss. In the long run, this, by whatever name we may call it, is the only way in which the telegraph systems of the world can be satisfactorily worked. We are profoundly sceptical as to the outcry against monopoly in Atlantic cables. Their multiplication beyond the requirements of traffic means ruin or amalgamation; and inordinate amalgamation means inordinately watered capital.

The varied and extensive character of the systems controlled by the EASTERN TELEGRAPH COMPANY, and the companies in working agreement with it, is shown in the very remarkable table which we are also able to publish this week. If we are not greatly mistaken, the facts here disclosed will be a surprise to most people. It seems almost incredible that in the short space of time during which these companies have existed they could have spread and extended their operations so widely and to such remote

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quarters of the Eastern Hemisphere. The EASTERN TELEGRAPH COMPANY and the EASTERN EXTENSION COMPANY, together with the SOUTH AFRICAN and the BLACK SEA Companies, own between them nearly 36,000 miles of submarine cables, besides 3,402 miles of land lines. To keep this vast system in working order requires constant and unremitting attention, and involves, of course, considerable expenditure on the maintenance of repairing ships. Even the British Government, with its very limited mileage of cables, have found it to their advantage to possess a suitably-equipped cable ship of their own; and, of course, these companies have long had theirs. We give this week a series of illustrations of the last new ship of this kind, built for the EASTERN TELEGRAPH COMPANY, and named the "Electra." It is probably the most admirably and completely-equipped vessel of her class ever yet built.

We cannot dismiss this subject without a word of regret that the submarine telegraphs of the world, which were projected and are owned almost exclusively by this country, are so indifferently protected by its Government. The initiative in this matter, as in so many others, has been taken by France; and the Conference relating thereto was actually held in Paris. Our command over submarine telegraphy ought to entitle us to speak with authority where its safety is concerned, and our interests dictate that we should be the first to be heard. We are sorry to say that this apparently is not the view of the Foreign Office, or the Colonial Office, or both combined; and the result is that, although some regulations have been framed that may prove of service, they are still very far short of what might be obtained if the British Government took any trouble in the matter.

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Sprague's letter is a treatise on the laws of electricity. As I had not seen his Second Edition, p. 299, so he has not read my papers, which date from before the Southport Meeting of the B.A. He will there find the "pans of salt-water" fully described. In his postscript, moreover, he does justice to my incomplete device, which I did not claim as new, except for this purpose. My intellectual status as a physicist is, perhaps, a shade higher in the zoological scale than he, or certainly Mr. Sydney Walker, at first intimated. I entirely acquit the latter gentleman of intentional discourtesy, though his former letter shewed a rather "hoity toity" tone from which his second is free. Here, for sheer weariness, I must leave controversy.

Two points, however, are of extrinsic value:—

1. I cannot accept Mr. Sprague's "sweeping" phrase that Kohlrausch's method of measurement is a "delusion;" nor has he given any proof that the body takes "a succession of reverse charges" like a condenser. Indeed, a thing which possesses only a few thousand ohms resistance cannot be called a condenser at all, except by wrong use of words. It is more like a faulty submarine cable, as Mr. Latimer Clark judiciously suggests; and the excellent method of Mr. Mance, to which Mr. Clark has drawn my attention, brought before the Society of Telegraph Engineers on May 8th, 1884, will probably prove of service. It is intended for "eliminating the effects of polarisation and earth currents from fault tests." In some suggestive remarks made on the paper in subsequent discussion, Mr. Clark describes experiments with artificial faults in cables thrown overboard. "The resistance of the fault," he says, "was taken with potentials varying from three to sixty cells, and it was found that in all cases, as the battery power increased, the resistance of the fault decreased with great steadiness." This also answers a question of Mr. Walker's. I may add that I *do* consider the human body an exception to the rules governing ordinary conductors, and hence arise mysterious and hitherto unexplained accidents.

I may name, in conclusion, that Mr. Glazebrook's paper published in the *Phil. Mag.* for August, on estimating the capacity of a condenser by means of a tuning fork, is under trial, and that by the kind help of Messrs. Latimer Clark, Muirhead, and Co. I hope to have the opportunity of endeavouring to balance the body against a small portion of one of Dr. Muirhead's duplexing condensers, which, like it, combine resistance, or rather conductivity, with capacity.—Yours, &c.,

Wandsworth, Feb. 2, 1885. W. H. STONE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As a discussion is now taking place in your columns upon "Personal Safety and Electric Currents," it appears to me an appropriate time to point out that I have recently suggested to the President of the Society of Telegraph Engineers it might be advisable that a committee be formed by, say, the Institution of Civil Engineers and the Society of Telegraph Engineers, for the purpose of inquiring into and reporting upon the subject.

As I feel, and I think most electrical engineers will acquiesce in my view, that the progress of electric lighting has been seriously retarded by the publication in the press of the accidents which have occurred, giving the general public the impression that *all* electric lighting currents are dangerous, I consider that good results would accrue from the publication of a report drawn up by competent men, and I suggested that such committee should consist of both electrical engineers and medical men.

Mr. Spagnoletti suggests that, as a preliminary step, a paper upon the subject should be read at the Society of Telegraph Engineers, and suggests my doing this.

I was not desirous of carrying out his suggestion, as I feel that there are several others far more competent to handle the subject than myself, but I have had the good fortune to secure the valuable co-operation of Dr. W. H. Stone.

I feel that if the paper merely consisted of a record of the accidents which have taken place, with a few observations upon them, it still might be productive of an interesting discussion in which medical men might take part; and with this in view I will ask you to publish this letter, in the hope that some of your readers will be able to furnish me with details of accidents, either fatal or non-fatal, which have occurred.

A form is being circulated amongst all those likely to be able to furnish particulars. I have already to thank Sir Wm. Thomson, Mr. Latimer Clark, Dr. Hopkinson, Dr. Richardson, Mr. Crompton, and others, for their kindness in furnishing lengthy replies.

I shall feel very much obliged to any of your readers who will do the same.

I am sorry to see that Mr. S. F. Walker speaks in such a dissatisfied tone as to what has been and is being done, and should like to point out that, although his letter is very lengthy, and contains a great number of suggestions, yet it does not add at all to our knowledge of the subject.

I cannot agree with him that the measurements Dr. Stone has made represent so much time wasted. It appears to me to be of vital importance to know the resistance of the human body under all conditions; and I would suggest that if Dr. Stone's clinical clerk does not feel inclined to submit to an exhaustive series of tests as to how much current he could stand in different parts of his body, &c., that Mr. Walker should do so himself.

Again, I am not with him when he says that very little can be done before the human body can be mapped out into circuits, &c., aad I certainly cannot see at first glance the meaning of the expression "that this vein being a conductor in motion sets up an E.M.F. within itself."

Are we to glean that the vein moves about to different parts of the body, cutting lines of force, and thereby acting as a dynamo machine?

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Most of the questions he asks would, I think, be answered by the results of *post mortem* examinations on those killed by electricity.

Another point appears strange. He says, "After the beautiful models and diagrams of the human body which I have seen, and which are public property, I will not believe it to be impossible."

What have the models to do with it?

Will any valuable result accrue from taking one of these models to pieces, and measuring its various resistances?

In another part he says, "We know that an electric current has the property when passing through a nerve of exciting that nerve to perform its natural function."

This is not strictly true, a current flowing steadily through a nerve or muscle produces no effect; it is only at the commencement, or cessation of the current, that such effect is produced.

In the case of continuous currents the muscle returns nearly to its normal position, and remains there so long as the even flow of the current continues. It might be advisable to point out that it appears not to be absolutely necessary, as Mr. Walker states, that the contraction of muscles should be preceded by a violent excitation of all the nerves which lay in its path, as the passage of an electric current has the effect of contracting a muscle from which the nerves have been removed.

In the next paragraph he is also in error in stating that in the case of the alternating current we should have excitation and contraction, followed by a momentary return to the normal state. Every muscle, of course, has its own moment of inertia, and above a certain speed of alternation in the current it cannot respond, and remains contracted; hence a man will grip the electrodes, whether the currents be continuous or alternating.

I fear that I have already trespassed too far on Dr. Stone's portion of the subject, but I should like to point out that thrombosis is produced by combination of haemoglobin contained in the corpuscles with certain constituents of the liquid serum of the blood; consequently, if Mr. Sprague's suggestion that certain structures are broken down by the shock or repeated shocks be correct, this would account for thrombosis.

I think Dr. Stone's experience with a Ruhmkorff coil, in which a spark leapt three or four inches in order that the current might enter in a little unhealed wound, is of great importance, and I had already pointed out to Dr. Richardson, F.R.S., that possibly it may be found that the skin resistance is so much in excess of the resistance of the moist tissues, that animals may be killed by currents the E.M.F. of which may be sufficiently low as to be harmless to the operators by the simple expedient of allowing the current to pass through the head of the animal between two sharp points which have been allowed to penetrate the skin, and this, I should imagine, without subjecting the animal to any material degree of pain.

There are a number of other points I should like to mention, but I fear I have already taken up two much of your valuable space.—Yours, &c., ALFRED R. SENNETT.

EFFICIENCY OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In *The Electrician* of 17th January I find a report by the jurors of the Vienna Exhibition on an incandescent lamp exhibited there. The particular lamps tested were 20 candle-power *nominal*, and the figures given show that when run to give this light the efficiency, or number of watts per candle, was 2½; and when giving 12 and 9 candles the efficiency of the same lamp was 3·13 and 3·77 watts per candle respectively. "Of course," continues the report, "when under-run in this way the length of life should be very considerable." No doubt it ought, or at least, at first sight, one would jump to that conclusion; but let us examine some of the terms employed in the above statement. "Under-run" has no absolute meaning, and can only be understood when referred to the term "20-candle." This, again, is a meaningless expression, and conveys no information unless accompanied by the reasons why the rate of work was fixed such that the lamp would give 20 candles. Were I to take a lamp, which, on economic considerations, ought to be run at 10 candles, christen it a 20-candle lamp, and then run it at 12 candles, I should be scarcely in a fair way of making its life *very considerable*. The process reminds one of the man who on finding his feet exposed during the night tried to lengthen his blanket by cutting a piece off the top and adding it on to the bottom.

It will of course be unnecessary for me to point out that knowing only the efficiency or watts per candle of a lamp is useless information. In a preliminary experiment lately made by me on a certain lamp I found that the watts per candle varied approximately as the inverse square of the watts absorbed. The equation to the curve found by taking a great many points is $(x + n)^2 = m\ y^{-1}$, where x is the watts absorbed and y the watts per candle. Now as n is small compared with x, and m is a constant, it will be seen that y, the number of watts per candle, approximately varies as the inverse square of the watts absorbed. This relation was found to exist between very wide limits, namely, from four to twenty-six candles. It will thus be seen that to give any information as to the relative merits of different lamps it is necessary to give a curve showing the average life of the lamp when run at various efficiencies. About as much information as to the merits of a lamp can be got from its so-called efficiency as idea of size of a body can be got from knowing that it is as big as a piece of chalk.

Sir William Thomson, in a paper communicated to the British Association at the York meeting, 1881, and Mr. Thomas Gray, in the *Philosophical Magazine* for September, 1883, have calculated the size of conductor required for the distribution of electric energy, in order that the sum of the annual cost for interest on capital, for depreciation, and for energy lost in consequence of heat generated in the conductor by the current may be a minimum. Now, a similar calculation may be made to find the efficiency at which a particular class of lamp ought to be run, so that for a given total light the sum of the annual cost for interest on the price of lamps in use, for renewing lamps, and for supplying electric energy may be a minimum. Without this a comparison of the so-called efficiency of different lamps is valueless and misleading.—Yours, &c., J. GORDON.

27th January, 1885.

THE DAVEY MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The letter of your correspondent, "Phœnix," in last week's issue has probably perplexed more young engineers than myself. He states therein that Mr. Davey's motor house, 9ft. by 6ft., is "not too big, but just big enough." I fail to understand why these dimensions should be considered just right by one who has evidently no idea of the size of the machinery within, as he goes on to inquire what the motor is.

Considering that Mr. Davey's domestic motor has been illustrated in nearly all the engineering papers during the last few months, and is described as being eminently suitable for driving dynamos, one would have thought that even so cautious a a person as "Phœnix" appears to be might have ventured to assume that this was the motor used.

He asks, "Why burn coke?" I ask, Why not? It is a very cheap fuel, and the absence of smoke in the products of combustion, thereby preventing flues, &c., being choked up, is probably the reason why it is so generally adopted for hot air engines, small stoves, &c.

As to the remarks of "Phœnix" on Mr. Davey's system of warming his house by means of the heat obtained from the motor, I confess they are beyond me. Nothing seems to satisfy him, material, thickness, diameter of pipe, or method of carrying it through the house. One is reminded of the famous leg of mutton which Dr. Johnson condemned as being "ill-fed, ill-killed, ill-kept, and ill-dressed."

Mr. Davey states that he adopts ¼ lead pipe, which I take it signifies piping ¼in. in diameter, and I do not gather from his letter that the pipe is used to convey water; but from the descriptions one has read, it appears that steam at or slightly below atmospheric pressure is used in the motor. Perhaps Mr. Davey uses this steam; if so, why should not the pipe be

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thin, the pressure being practically *nil?* As to the material, my experience in the workshop has shown me that lead pipe is far easier twisted about than iron.

Of course if "Phœnix" prefers to use iron pipes of 1¼in. diameter and to go to the expense of making recesses in his walls, he is welcome to do so; but, according to Mr. Davey, cheaper pipe can be used and carried anywhere about the house where required, and fixed with very little trouble and expense, giving satisfactory results.

As a young engineer anxious to learn, I venture to inquire of "Phœnix," in his own phraseology, If this can be done, why not?—Yours, &c.,

A YOUNG ENGINEER.

DYNAMO CONSTRUCTION.—A CORRECTION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I regret to see several rather serious misprints in my letter in your issue of this date.

The second equation

$$E_{,} = K\,\omega\,\frac{W}{a}\,V \quad \textit{should read}$$

$$E_{,} = K\,\omega\,\frac{W}{a_{,}}\,V.$$

The dash is also omitted farther on in "W lbs of wire, *d* mils in diameter," which *should read d,* mils in diameter.

Again, in giving a formula for the number of turns of wire around the magnet coils, "$V = \frac{\omega}{C_{,}}$" *should read* $\gamma = \frac{\omega}{C_{,}}$, and farther on, where the value for $C_{,}$ is substituted, "$V = \frac{\omega E_{,}}{E C}$" *should read* $\gamma = \frac{\omega E_{,}}{E C}$.

But the "hardest cut of all" is where the words "*my* comprehensive formulæ" appear instead of *any* comprehensive formulæ. No doubt it is nearly impossible to avoid such errors entirely where it is impracticable to allow correspondents to revise their proofs, especially if the correspondents happen to be bad writers, as I fear is my case.—Yours, &c.,

G. C. FRICKER.

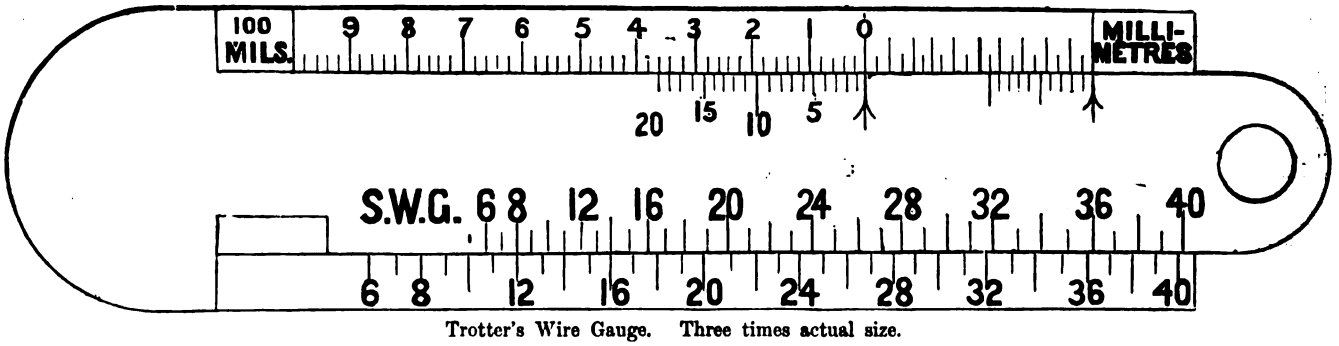
7, Charlwood-road, Putney, Jan. 31, 1885.

LIGHTING YACHTS BY ELECTRICITY.

The new yacht "Retreiver," belonging to Mr. O. Randall, has just been fitted throughout with the electric light by Mr. Geere Howard, of 36, Cleveland-street. The saloons, cabins, and engine room are lighted by incandescent lamps of 20 candle-power each, distributed as follows:—Six in the saloon, three in the chart room, one in each of the cabins and passages. The engine room and passages are fitted with portable lamps, so that any part of the vessel can be lighted at will. For this yacht, having a magazine, as it carries five guns, a special arrangement has been designed for lowering an incandescent lamp down into the magazine, doing away with any possibility of fire or explosion through accidental ignition of the powder. Besides the incandescent lighting an arc lamp of 3,000 candle-power, fitted with all the most recent improvements, is arranged for use as a search light. This search light is fitted with a powerful projector and lens. Both the search light and the incandescent lights are arranged in parallel arc, the current being supplied by one of the Crompton compound type of dynamos, driven direct by a Tower spherical engine. The engine and dynamo are fixed upon the same bed plate, and only occupies a space of 4ft. by 2ft. 7in. by 18in. The lighting of the vessel is not the only use made of electricity on board, for an arrangement is being made by which the guns can also be fired by electricity from the chart room, and the arrangement will be such that either or all of them may be fired simultaneously or independently as required. The whole of the installation is of a special character, on account of the small available space, the whole of the designs having been made and the work carried out under the superintendence of Mr. Howard. It seems to us that the owners of yachts will do well to follow the example of Mr. Randall, for as these vessels are mostly built for pleasure purposes, and the electric light being calculated to be superior in every respect to any other kind of ship lighting, it should become the rule without an exception.

[A number of letters, although in type, are unavoidably crowded out. Amongst these are communications from R. H. M. Bosanquet, Douglas C. Bate, and W. A. Rudge.]

TROTTER'S GAUGE.



Trotter's Wire Gauge. Three times actual size.

Following on the publication of their admirable "Table showing the Relative Dimensions, Lengths, Resistances, and Weights of Pure Copper Wire," now so well known in the electrical world, Messrs. Walter T. Glover and Co., of Manchester, have brought out and patented a new wire gauge, the inventor of which is Mr. A. P. Trotter. This gauge will be found to be one of the handiest invented, as it gives five measurements at one operation, each of which is registered with great accuracy. The largest scale on the gauge is that of the new Board of Trade Wire Gauge, styled the S. W. G., or Standard Wire Gauge. This is marked from No. 6 to No. 40, every size between these two numbers being distinctly shown at once without the necessity of first counting the number of mils the wire may measure, and then referring to a table to see what particular number of the S. W. G. is being measured, as is at present the case with most gauges now in use.

There is also a scale of "mils," or thousandths of an inch, and a millimetre scale, both of which, in addition to the S. W. G., are on the front of the gauge. In this way not only can the S. W. G. number be seen at once, but the diameter in mils. and millimetres can be read accurately (not approximately) without further measuring.

On the back of the gauge is another scale, showing the area in thousandths of a square inch of any wire the gauge may be measuring, and this scale also serves as a scale of amperes (calculating on the safe basis of 1,000 amperes to the square inch), so that on the scale of areas may be seen at a glance the *safe* current for any wire. Again, from this scale of areas may also be calculated (approximately) the *length*, *weight*, resistance, loss of horse-power, &c.

Indeed, the value of the gauge is such that we feel assured that electricians generally will not be slow to recognise the ingeniousness and skill of the inventor in providing so useful and practical an instrument for facilitating rapid and accurate calculations.

As we have said five measurements are made at one operation, viz., size in 'mils' and millimetres, area in square inches, and current in

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amperes; while the length, weight, resistance, loss of horse-power, and also Sir William Thomson's very safe rule of 0·5 ampere to the square millimetre, can all be readily calculated from it.

The working of the gauge will be easily comprehended by an examination of our illustration. The three scales on the front of the gauge are verniers, and show the correct reading in S.W.G. (standard wire gauge) "mils" and millimetres of any wire or other article nipped between the jaws of the gauge. The gauge works like a slide rule, and all the readings, as we have already explained, are given with once measuring, the scales being so arranged that all their numbers register correctly without re-gauging.

COMPANIES' MEETINGS.

The Direct United States Cable Company (Limited).

The fifteenth ordinary general meeting of this Company was held at the City Terminus Hotel, Cannon-street, on Thursday last, Mr. John Pender, M.P., presiding.

The SECRETARY (Mr. J. W. Fuller) read the notice convening the meeting. The report and statement of accounts were taken as read.

The CHAIRMAN then said: Before moving the resolution for the adoption of the report and accounts, I shall, as usual, give you a few figures relating to the report, and make a few remarks which I have no doubt will be interesting to you. The revenue for the half year to 31st December last, after deducting out payments, amounted to £68,824 5s. 2d., and the working expenses and other payments to £18,607 15s., leaving a balance of £50,216 10s. 2d. as the net profit of the half year, making, with £2,786 8s. 7d. brought from the previous half year, a total of £53,002 18s. 9d., which has been appropriated as follows:—Interim dividend of 5s. per share, to 30th September, £15,177 10s.; interim dividend of 5s. per share, to 31st December, £15,177 10s.; amount set aside to reserve fund, £5,396 15s. 10d.; balance carried forward, £17,251 2s. 11d. The revenue shows a decrease of about £4,650, as compared with the corresponding period of 1883, owing to the continued depression in trade with America, which has affected our earnings during the last three or four years. The working expenses in London are higher, but the expenses at stations continue to show a reduction as compared with 1883. The expenditure in the past half year has been affected by the alteration of tariff, involving extra work, and outlay in printing and stationery; by the cost of advertising repayment of debenture loan, and by other causes more or less of a temporary nature. Taken on the whole, however, the working expenses and other payments are less by £3,200 than in the corresponding six months of 1883. The reserve fund has been charged with £73,367 14s. 7d., which, with the addition of our floating capital, has been applied in paying off our debenture loan of £100,000, at the same time reducing our expenditure on capital account, as shown in the balance-sheet. The balance of the reserve fund, fully invested, now stands at £300,000. We have realised £50,000 worth of Consols, in connection with repayment of the debenture loan, leaving our investments standing at a cost of £304,221 4s. 1d., which is considerably less than their present market value. These figures, gentlemen, will impress upon you the exact financial position of the Company. Now it is my duty to put before you to-day a plain and straightforward statement. I wish the Directors and the shareholders at a time like this to have a thorough understanding one with the other. When I had the pleasure of addressing you at the last half-yearly meeting I referred very fully to the position of the Company, and also to the then impending competition. I stated that Messrs. Bennett and Mackay had laid one cable, and that they were about to lay another; that when the two cables were completed we should then be face to face with an active competition. There was an idea at one time that the Bennett-Mackay cables would open at the same tariff that we were then working at—viz., 2s. per word; had they done so it would have been better for them not only at the present time but also in the future. They had, however, made so many promises to the public, and having stated that their principal object was to give a cheaper telegraphic service, and to break down what they considered to be a monopoly, that I presume they felt bound to open with a lower tariff. But did this action arise purely from a desire to benefit the telegraphing public, or from a desire to enrich themselves out of what they conceived to be a very profitable business? Or was there not a little spice of jealousy in their action against certain parties on the other side of the Atlantic, who had taken a very prominent part in telegraph communication, not only there but in connection with the submarine system? Their motives they best know themselves. However, I had more than one conversation with Mr. Bennett, and at one time thought he would take my advice, and I had also a considerable amount of discussion on the subject with the late Mr. Garrett, who I may say in passing was a very shrewd, far-seeing, and intelligent man, and whose loss is a very serious one to the commercial community of America, as there were few men there who exercised a sounder judgment, and who were more successful in developing and placing in the highest possible position the leading railways in America as the one over which he presided. I was satisfied that additional cables in the Atlantic at that particular time meant simply a waste of money, the existing cables being equal to carrying two or three times the amount of traffic offered; and most of them being duplexed, it placed the cable companies in a position far ahead of the natural growth of traffic. I therefore, after a discussion with Mr. Garrett, prepared a statement, which I handed to him. I also sent a copy of it to Mr. Bennett, and I gave instructions that a copy should be handed to Mr. Mackay. Whether it ever reached Mr. Mackay's hands, of course I cannot say. I am told it did. However, I believe that the facts given in that document decided Mr. Garrett in withdrawing from the cable combination. It is just possible that Messrs. Mackay and Bennett may have imputed my sending this document to them to other motives than those which influenced me. My desire, however, was to prevent them from getting into a business which I knew would do no good to them, but might do serious injury to the large body of Atlantic telegraph shareholders. I hope they will now see that the figures gave a very fair and straightforward statement. I showed in that document that there was a certain amount of money earned in the Atlantic at a certain rate, and I gave them figures, based upon our extended experience, which showed that if the two proposed cables secured their numerical, or cable-for-cable proportion of the total Atlantic traffic, viz., one-fifth, it would, nevertheless result in a loss of £40,000 per annum after they had provided for working expenses and a proper reserve fund, but without taking into account a very large annual expenditure for a repairing steamer. My facts, however, did not prevent them going on with the venture, and they are now gathering their experience from the working of their own cables, and I shall show you presently what I believe the result of that experience will be. Firstly, I would say that their first act of opening with a tariff of 1s. 8d. per word, and thus forcing a reduction from 2s. per word, was literally throwing away £150,000 per annum; because, so far as we can see up to the present moment, also from previous experience, the reduction will not generate any increase of messages sufficient to recoup us for that loss. And I doubt very much, if we were to take this sum and scatter it over the traffic which has passed, whether we should find that it had been of any material benefit to those engaged in telegraphing. But, gentlemen, it has been—or, rather, I may say, it will be—a most serious loss to the companies, the pioneers who have done so much to promote and maintain an efficient submarine service in the Atlantic; and if continued it will make a material difference in the dividends which we shall be able to pay to you in the future, extremely moderate as they have been in the past. Although I am addressing plain facts to you—and I am putting the case clearly and distinctly before you—I do not wish to do it in any way to deprive you of hope for the future, because I think we have it now pretty much in our own hands to make the future very hopeful indeed for submarine telegraphy; but before we get to the hopeful position, I expect we must go through a little tribulation.

Now we have to consider in what way can best protect the interests of our shareholders at the present time. Messrs. Mackay and Bennett are, of course, gaining experience; but probably before many months have passed, when they come to make their balance, they will find out that the venture they have gone into is one which, from our point of view and from the mode in which accounts are generally kept, must show them a most unsatisfactory balance. As shrewd Americans, they have been accustomed to high rates of interest upon their investments, and no doubt their money was invested in America, probably in undertakings which, judging from what one sees and hears, yielded them a return of from 6 to 8 per cent., probably more than that. They have had to realise some of these investments, no doubt, to start this new venture. They will have an opportunity of seeing this statement, and I hope they will not think I am interfering in their affairs if I put before you what I think will be the result of the working of their new investment compared with the old. I think I can show you something of what their first balance-sheet is likely to be. Take their capital at £1,500,000, and take the whole of the earnings of the Atlantic cables at £750,000—there are ten cables—give the Mackay-Bennett cables their full proportion, which would be one-fifth; one-fifth of £750,000 is £150,000. From this must be deducted £50,000 for working expenses, at least £50,000 for reserve, which would only be £25,000 for each cable, whereas looking to the enormous risk and expenses of maintaining cables, it ought to be £50,000 for each cable. Then we must deduct the expenses of the repairing ship, say £10,000, which is a very low estimate, and £5,000 for duplexing the cables, making up altogether the sum of £115,000, which, deducted from £150,000, leaves £35,000, or 2¼ per cent. upon their capital of £1,500,000.

Now, assuming, as I think we have a perfect right to do, that this million and a half of money which they have put into their cable venture had been previously invested in American securities at from 6 to 8 per cent., but for the sake of argument we will take it at 6 per cent., which is a fair rate for American investments, the result is they would have received on this million and a half £90,000, as against the £35,000 they now get, which would be a loss of £55,000, or 3⅔rds per cent. upon their cable venture as compared with their previous investment. I may say also (and this may be valuable information for them) that since the direct cable was opened we have spent £116,000 for repairs, although we have been on the whole fortunate, and I think they can scarcely expect to be more fortunate than we have been, while the Anglo-American Company since their formation have of course expended a very much larger sum than this.

Now, I think, gentlemen, that we may reasonably suppose that Messrs. Mackay and Bennett cannot be very much in love with their new investment, and the question is whether they are likely to continue to work at a rate which gives them such an unsatisfactory return. Now, bad as it is for them, I am sorry to say it is in some respects worse for us. They had their cables made and laid at a time when they could be made much cheaper than they could years ago. That is in their favour, but we have against that all the knowledge and experience, and what I may term the goodwill from having done our work so well, so that in any competition I think we shall always get our full share of the business. But is it wise on their part or ours to work our cable system at a rate which is so very unremunerative? I have always said that wholesome competition is advantageous up to a certain point, but very dangerous when it comes to a point at which you might be deprived of a sufficient income to maintain

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a thoroughly efficient service, and we are now in that position. We are not in a position at the present tariff to put by the reserve we ought to do, but fortunately in the past we have built up a good one, and you will find that we have been wise in securing such an important reserve as we now possess. The fact that at the present moment there are four cables in the Atlantic which are interrupted, in addition to some of the shorter sections, will show the absolute necessity of a large reserve fund, and although the prospect of repairing those cables is good, still there is always an uncertainty in repairing submarine cables; but there is one thing that is always certain, and that is, that the expenses of repairing are very great indeed. There is, I am sorry to say, amongst those I would call the speculative dealers in Atlantic cable property, a great desire to stop the further accumulation of a reserve, with a view to getting an additional shilling or two upon the dividend; but I say this is more on the part of the speculative holders than the permanent holders, and I hope the permanent holders will always raise their voices against any policy which would lead to a smaller reserve, and consequently a lessened security for their investment. Nor are we in a position to maintain the dividend we have hitherto paid if this reduced rate is to continue, as we can see no present prospect of any increase in the traffic at these low rates to recoup us for the loss which has been caused by the reduction. I think it may interest you to know that during the last two years the income from Atlantic telegraphy has been, for 1883, £939,000, and for 1884 £888,000, the tariff being 2s. per word during both years. Thus, you see, the receipts for 1884 show a decrease as compared with 1883, due to the depression in trade in the States and elsewhere. We have found the development of the traffic depends entirely on good or bad trade. At the most favourable times and tariffs the total revenue has never reached a million per annum. There is in fact only a certain amount of money spent in telegrams; the reduction of the rate does not sufficiently increase the number of messages; and, therefore, it is only by fixing such a rate as we consider not oppressive to the sender that we can hope to make it remunerative to our shareholders. I think we have proved this pretty well during the time that the present Board have had the conduct of this Company. The present rate cannot continue long, but still we are in no great hurry to move, at least, until our competitors have gathered a little more experience. But I think I may say, without much hesitation, that if we cannot agree to establish a rate which will be satisfactory to our shareholders, we must make such arrangements as will make it as bad for all parties concerned; but I wish to say that if we are obliged to go to a low rate for a time—and I wish this to be distinctly and fairly put to the meeting and to the public—the public will eventually have to pay for it, for we should by and by have to establish such a rate as would not only enable us to recoup ourselves for losses sustained, but also to return to our shareholders a fair dividend and provide a good reserve for the future. At the present moment our cable is interrupted, but arrangements have been made for its repair, and I hope, if we have anything like moderate weather, that we shall soon be in working order again. The interruption in our cable at the present time does not in any way interfere with our proportion of the earnings, as we are guaranteed by the Anglo and the other associated companies. That is one of the great advantages that accrue from the prevailing arrangements entered into with them. But were any interruption to occur to the Bennett-Mackay cables it would mean an entire loss of revenue to them. I have given you this very plain statement, as I think it desirable you should know, and that the public generally should know, and that Messrs. Mackay and Bennett in particular should know, something of the working of submarine cables based upon the long experience of a Board that has paid a great deal of attention to submarine telegraphy, and I have no doubt when they have learned their lesson as we have learned it, that they will find that it was more easy to get into a very unremunerative operation than to get up a successful enterprise of that description. I have now to move "That the report of the Directors, dated 27th January, 1885, together with the statement of accounts for the half year ended 31st December, 1884, annexed thereto, be, and the same are hereby, received and adopted."

Mr. Wm. Ford seconded the motion.

Mr. Jackson, while expressing his pleasure that the Board had maintained their loyalty to the principle of the renewal fund, thought that, under the circumstances described by the Chairman, they must look forward to somewhat reduced dividends. As the Board had a considerable amount of leisure at their command, they might, he thought, turn their attention and intelligence to the development of the traffic of Atlantic telegraphs generally without reference to competitive schemes or opposition. It seemed to him that it was not asking too much of such experienced gentlemen to suggest that they should do something in order that the Company should be in the van of progress. As one step in advance he recommended the institution of social telegrams. He said that the telegraph companies might and ought to consider not how high they could keep up their tariffs, but how by extra exertions and improvements they could increase the value of their property, and promote the interests of the public. He also referred to the great number of press messages carried by the Commercial Company.

Mr. John Newton asked if the Board had duly considered a question which he had raised on a former occasion—namely, whether it would not be better, in the interests of the shareholders, to reduce the denomination of their shares from £20 to £10, which he believed would give them a higher relative value in the market.

The Chairman: There is just one point in Mr. Jackson's remarks that I want to reply to—and I am always glad to reply to Mr. Jackson's remarks carefully, because I know that he takes a very considerable interest in the question, and any suggestion coming from a practical man we always like to meet in the way in which it ought to be met. In the first place, I have stated on previous occasions that I think there should be something done in the development of social telegrams, and I have no doubt that that will attract attention before long. But I think I stated a little time ago that there are four cables interrupted in the Atlantic at the present time, and instead of Mr. Jackson's idea being the case, that we are sitting counting our fingers just now, I assure you that the present time is probably one of the most anxious that the managers possibly could have. I see a gentleman here who has perhaps a greater experience in the practical working of telegraphic traffic across the Atlantic than any other man, and I know his time is fully occupied at present so as to keep up our reputation of being the best carriers, the quickest carriers, and the most certain carriers, when we are more or less what I call handicapped by the loss of these four cables. But you may rest assured that all our wits will be exercised to meet the traffic in an efficient manner. Another thing which Mr. Jackson referred to—namely, the parade in the newspapers of press messages coming through the Commercial Company, demands some explanation. It so happens, I believe, that that has arisen from a policy which we have considered a wise policy to follow; and while Mr. Bennett has always said that his newspaper line would be pretty well employed by newspaper telegrams, it appears that a very large proportion of the telegrams are sent at the rate of 5d. per word. Now, we thought if we found that we could employ our cables at 1s. 8d. it would be exceedingly foolish to employ them at 5d., and therefore we wished Mr. Bennett's cables to get the full advantage of this press system, so that while the press represents messages at 5d., our commercial messages stand at 1s. 8d. I do not mean to say, when the time comes round, and we are in a position to do what we desire to do, we shall not be too glad to cultivate the press messages. In the meantime we think it is better that they should carry them at 5d. while we are carrying ours at 1s. 8d. As to Mr. Newton's remarks, we have considered the question he has raised more than once. The Direct Company is more or less a distinctive Company, and I suspect somehow or other that the maintenance of the price as it is at present does not concern the general body of the shareholders, and we have very little to consider what the public outside our own shareholders may think about the matter. It is a question I am not prepared to give a decided answer to. If we were to reduce our shares to £10 and increase the number of our shares, they would stand in the market at about £4 10s., and I think we stand better at the present time by their being quoted at £9 10s. I think practically there is not much in it so far as the shareholders are concerned. But, still, it is a question that we do not say to Mr. Newton we will not look at. It is one that may come up again, and when it does you may depend upon it that it will be considered in the interests of the shareholders. I was just going to say, when I was reminded of the circumstance by our accountant, that our shares at present stand probably lower than they ever did. There is an idea abroad that we are what we call a one cable company, and if the cable should break anywhere our returns must cease. But our arrangement with the Anglo-American and other companies is that our cable must be broken for twelve months before it makes any difference in the amount that we take out of the general pool, and from our past experience we hope that a month or two will be the longest period that it will be interrupted; and therefore, although we stand as a one cable company, we are actually backed up, and have the advantage and security of seven other cables. Now, just to give you an idea of our position, our reserve fund, I may say, is worth to each shareholder for each share £5 11s. 6d.—that is to say, you have in your reserve fund alone, apart from your cable, £5 11s. 6d. which is on dry ground, well invested and secured. You have that in hand if your cable were to break to-morrow. Now, that is very satisfactory, and our reserve fund, if we continue to manage this Company as successfully, will show a continued and steady increase. But, while I have put things very plainly before you, I have no hesitation in saying that we are looking forward to a very great and important change in America, because a great country like America cannot be permanently depressed. The vitality of America is something enormous. The moment that begins to roll in the right direction you will find a great rebound, and telegrams will naturally follow. I do not mean to talk otherwise than as a plain and straightforward business man, and I expect Messrs. Bennett and Mackay to be the same; but I am very much mistaken if they had any other idea of going into this venture than to get money out of it, or they are not like other men, and I think when they are finding only 2½ per cent. return from it they will be the first to consider how they can improve that return on the capital invested. We make no approaches to them. We think it is better that they should gather their experience from the adversity of the situation. Mr. Mackay is a very rich man, but rich as he may be a million and a half is a large sum of money, and judging from his past I think his future will be to try and improve upon that 2½ per cent. And, gentlemen, I am sure he cannot benefit himself without benefiting us; and as we have a big reserve fund we are quite prepared to take a dignified position without being vindictive, and when the time I have foreshadowed comes round we shall benefit from the change which he may consider it desirable to make in the interest of the cables.

The resolution was then put, and carried.

Mr. Stokes proposed, and Mr. Jackson seconded, a vote of thanks to the Chairman, which was cordially passed.

The Chairman: Gentlemen, I have to thank you on behalf of myself and colleagues, and let me say this one word in conclusion. We have for the last seven years, I think, had the pleasure of meeting you every half year, and declaring to you not a large but upon the whole a fairly satisfactory dividend. We have, as I have said, in the meantime accumulated a very considerable reserve. Let us hope—and six months is a long time—when we meet you next time we may be able to congratulate ourselves on the prospect of recouping any little sum we may have lost during the present state of affairs.

The proceedings then terminated.

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The Eastern Telegraph Company (Limited).

The twenty-fifth half-yearly ordinary general meeting of the shareholders of this Company was held on Thursday, January 29th, 1885, at the City Terminus Hotel, Cannon-street, London, under the presidency of John Pender, Esq., M.P.

The notice convening the meeting and the minutes of the last meeting having been read,

The CHAIRMAN said: I presume that you will take the report as read; and therefore, with a view to give you some little detailed information, I shall refer first to the figures in it. Our revenue for the six months ended the 30th September, 1884, amounted to £309,569, against, in the corresponding period of last year, £283,070, being an increase of £26,499. The greater part of that increase, something over £19,000, was derived from long Government and press telegrams, which have compensated us for the falling off which has taken place in the number of commercial telegrams. The Black Sea Company's traffic shows the sum of £2,023, against £623 in the corresponding period, which had to bear the cost of two repairing expeditions. During the six months under review we have had no interruption on the Black Sea line, and our revenue has consequently improved. Our receipts for traffic with India were less by £4,000 than for the correponding six months. To this I shall refer later on. The balance sheet shows that we have £3,498 in shares of the Mediterranean Extension Company, now in liquidation. This amount will, we expect, be realised at a profit before the next accounts are published. Interest on our balances and transfer fees have amounted to £540 more than last year. The working expenses of the Company were £284,907, against, in the corresponding half year of 1883, £80,849, or an increase of £4,058. This is mostly of an exceptional character. General expenses in London show an increase of £2,542. This is accounted for to some extent by the suit brought against us by the Central News Company, and other expenses. The working expenses at the stations show an increase of £1,994. This is accounted for by the increases and decreases in the following accounts under this head:—Salaries and wages at stations have increased by £2,045. We have opened during the six months four new stations—at Suakim, Piræus, Patras, and Katacolo. There are also six months' working expenses of our new station at Glasgow, against two months in the corresponding period of 1883. There is an increase in the travelling expenses of £1,369. There are the expenses under this head of forwarding clerks to the new stations, and expenses incurred in bringing witnesses home for the Central News action, their expenses in London during the trial, and sending them back to their respective stations. On the other hand there is a considerable decrease in the following items included in station expenses:—Maintenance and renewals of electrical instruments are £1,028 less, maintenance of land lines £436 less, repairs and renewals of furniture £180 less, and repairs to stations £433 less. Office expenses in London also show a decrease of £122; stationery and printing in London are £95 less, and expenses in connection with the cholera were £463 less, and the expenses of the issue of 4 per cent. Debenture Stock were £984 less. This accounts for the sums which I have named. The item of depreciation of cable stores shows an increase of £1,019. There is a new item of £500, being the proportion of the cost of the Suez-Benha land line and construction of cable tanks at Suez. It is absolutely necessary to keep at special stations tanks where we have cable, so as to keep it in a satisfactory state. The charge this half year for cost of the Lipari and Messina cables is £884, against £1,000 for the last five half years. The capital cost of those cables, namely, £5,884, has now all been charged to revenue. I may mention that this is a valuable item, and at the same time we have paid the whole cost of it out of income. The expenses attending repairs and renewals of cables are £31,189, against £29,520, or an increase of £1,669. Full particulars of the work done by our ships are given in abstract "C." After charging all expenses, including income tax on our net revenue, providing for interest on debentures and debenture stock, and preference shares, we are enabled to pay a dividend with bonus at the rate of 6 per cent. per annum and carry forward £30,364, against £13,679, in 1883. I need not give you the particulars of wages and other items. They are all more or less matters of detail. But I have given you pretty well the result in the figures which I have mentioned. And I think, ladies and gentlemen, I may congratulate you now on the report which I have placed before you.

There is one point referred to which I should like to mention—that is the traffic with India. We know very well from long experience of the telegraph system that increase or decrease in the number of messages transmitted depends more or less on the state of trade. There has been a very marked depression of trade in India and a very marked depression of trade in England. We at one time—last year—brought a large quantity of grain from India. The price of grain has been so low in this country, however, that that grain could not be moved this year, and having some connection with Indian railways myself it seems to me remarkable the enormous decrease which has taken place in the returns of traffic on the railways in India simply on account of the depression of trade there. Where there is depression of trade transactions in the way of telegraphy are very much less. Still, we present a good accconnt, notwithstanding this depression, and that good account arises from the state of things in China. I must not say that France is at war with China, as this would not be strictly correct; but there is fighting going on between China and France, as you see from the papers. The result is that this leads to a considerable amount of telegraphic communication being carried on, and we have derived benefit from it. But, looking at the depression of trade which has prevailed for a considerable time, I would rather trust to buoyant and active commerce than to war operations for a successful return on our enterprise.

The next business I have to refer to is one that is very interesting and of very considerable importance. When the report which is in your hands was printed we stated that all our cables were in perfect working order. To-day we have several cables interrupted. But, thanks to our arrangements and having our ships placed at a proper point to meet immediate repair requirements, I hope within a very short time indeed that we shall have our cables at work again. There is one point I wish to impress upon you more particularly—that, although we have breaks, we know where they occur, and have perfect confidence in being able to repair them. That, however, leads to this:—That we cannot do without ships, and it is important that we should have them placed at different points. Ships are more or less expensive, of course, and I have often said that they are most profitable to the Company when they are lying in dock doing nothing. Still we cannot do without them, and having them placed at proper stations enables us to repair the cables promptly when they are broken. We have also looked forward, probably beyond what some people would give us credit for. We have our system so arranged in the Mediterranean that if we had one, two, or three, or even four cables interrupted, we should still be able to conduct our important traffic with the Continent, and our large traffic with India, China, and Australia. We have—probably what you are not aware of—many alternative routes. During the present pressure of war intelligence and urgent messages on military affairs, we have been able to utilise our two cables from Alexandria to Malta and Marseilles, then from Alexandria to Zante and Otranto, from Zante to Trieste, and from Alexandria to Constantinople and Odessa. We have those four alternative routes to the Continent and Egypt, besides the line *vid* Gibraltar and Lisbon, which has been totally interrupted for the last few days. Therefore, ladies and gentlemen, we are now with many interruptions still doing our work in a way which the public can have no cause to complain of. There is one matter which I would like to refer to. I do not think it is out of place in doing so at a meeting like this. This Company is very largely indebted to those important messages which the correspondents of the different daily newspapers from time to time pass over our lines. We have received on more occasions than one telegrams that have cost the papers about £300. They have been sent by special correspondents of the papers at the seat of war. Yesterday brought us the very sad news of the death of two men, one of them pre-eminently great as a Press correspondent. I refer to Mr. Cameron; the other gentleman was Mr. Herbert. Mr. Cameron was the correspondent for the *Standard*, and Mr. Herbert for the *Morning Post*. Some of those around me had the pleasure of knowing those gentlemen. The public are greatly indebted to those men. We, as a body, are equally indebted to them. You see with what valour they have acted, and we know that the position they occupy is so different from that of military men who are crowned with glory by every success. But these gentlemen have to work inspired only with the knowledge that they are doing their duty to their employers and the public, and I look on them as greater heroes than those who have such brilliant rewards before them. I am sure you will agree with me in expressing regret at the great loss which the nation has sustained in the death of those two men [applause].

The last time I had the pleasure of addressing you I mentioned that we had connected Suakim with our system, and that Suakim was likely to be the opening to the Soudan. I referred to it because it was then generally supposed that any expedition sent from this country would go by Suakim to the Soudan. I am not prepared to give an opinion myself, but when I look at the hundreds of thousands of pounds that have been spent in going in that direction compared with the millions spent in going in other directions, and when my opinion is also the opinion of men of great experience, I simply say that I regret on many accounts that Suakim was not the road by which we approached the Soudan. I believe if the railway had been made it would have served a double purpose. It would have developed a new and great trade in that country. It would have prevented that slave trade which England has done so much to keep down, and in every respect I think the result would have been more satisfactory had Suakim been the way of approach to the Sondan. Still, all honour to those men, and although we are not deriving the same amount of telegraphic communication which we had at other times, we trust the result will be beneficial to the nation.

We have completed arrangements, and obtained now possession of the Mediterranean Extension Company. We have acquired it at a moderate price, and it now forms one of the links in our chain. We have done the same thing with the Direct Spanish Company, which is not in a very satisfactory state at present. But it is a link which may become a very important link in our system. I mean to say with regard to the Direct Spanish Company that we have acquired such an interest in it that we control it, and it will, I believe, become eventually a very important link in our system—at least, as a support to our system.

I have another matter to refer to, and you will excuse me if I speak at length, as I am very desirous that you should know everything we have done of any importance during the last half year. When I last addressed you I stated that we had made arrangements with the Greek Government which were of a very satisfactory kind. They were so satisfactory to the Greek Government that they proposed that we should make a still further connection with some of their outlying islands, and they offered us an extension for ten years of the subsidy they gave us, which will make it thirty-three years in all. The amount is £6,500 a year, and I believe the fresh extensions will cost us something like £6,000, so that, on the whole, that is not an unsatisfactory arrangement. We have also opened a station at Perim, in the Red Sea. One of our cables ran within a mile or two of this island, and an enterprising company established there a coaling station and applied to us to land our cable there. We have done that under a guarantee that our expenses will be paid, and we expect that the traffic from it will be something considerable eventually. The whole of our mercantile fleet is composed of steam ships, and they must coal somewhere, and what is the value of our great ironclads if we have not good coaling stations? That is going to become a great question of the day, and it is the interest of this Company, as far as we can, to

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follow the flag—if we can follow the flag with the satisfaction of knowing we are benefiting our shareholders by so doing. I think I have gone through nearly all the points referred to in the report, but if I have omitted anything, or if there is any question that any gentleman would wish to put to me, I shall be very glad to answer it. In the meantime, I beg to propose "*That the report and accounts of the Directors to the 30th September, 1884, submitted to this meeting, be and they are hereby received and adopted.*"

The VICE-CHAIRMAN (the Marquis of Tweeddale): I beg to second that motion.

Mr. E. P. EVANS (a shareholder): I should just like to ask a question. But I may first say that the praise I could wish to bestow on those concerned in the management of the Company is beyond what I can express. We are largely indebted to them for the results they have shown. With regard to the question I am desirons of putting, is it necessary that our reserve fund should be kept at so large an amount? This has been accumulated out of profits, and belongs to the shareholders past and present, and to a certain extent we have earned as much profit as we can have. It appears to me that another additional shilling bonus would not have reduced the reserve fund except by £19,000, and would not have affected materially the substantial position of the Company. I really do think, unless we hear from the Chairman some explanation that this reserve fund should be kept at the large amount it at present stands at, that there might have been an additional shilling bonus given to us. Perhaps the Chairman will be kind enough to explain why this reserve fnnd is kept at so large an amount, and why is it necessary that that should be done?

The CHAIRMAN: Does any other gentleman wish to speak? I am very glad to have an opportunity of replying to this question of the reserve fund. Probably there never was a time in the history of submarine telegraphy when the question of reserve fund was likely to be more prominently brought forward than the present. I will refer to companies outside ourselves. There are four of the Atlantic cables interrupted at the present time. If they had not their reserve fund behind them the value of that property would go down in the market hand over hand. It is the reserve fund which is our backbone, and as we get a fair amount of interest on it you are getting not only the support of that reserve fund for maintaining the value of your shares in the market, but you know perfectly well that if any expenditure is required at any time you have the means to provide for it. In our Company we have a large reserve fund, and we have also a depth of water which does not give us any inconvenience beyond anxiety as to time required to repair any break that we may have. But if we had provided nothing to stand behind us it would have been bad management on our part.

Mr. WATKINS (a shareholder): Is the Company receiving any interest on the Direct Spanish debentures?

Mr. JOHN NEWTON (a shareholder): As to the earning capacity of the reserve fund—if you carried to revenue the interest you receive on your reserve fund we should have the satisfaction of seeing what is our exact revenue from that. But you carry some £10,000 a year—much more than that, in fact—not directly to reserve, but to the reserve fund. If instead of that you carried it to revenue account, it would show our profit larger and our income larger, and I think the interest should be carried directly to revenue instead of to reserve fund.

The CHAIRMAN: In reply to Mr. Newton, I think I have very often stated that we are very much in the hands of our accountants—public accountants, not the accountants at our office. I have also stated that our accounts should be kept by men perfectly independent of us; and there are certain principles which are recognised by those accountants, and they strictly follow them out. Mr. Griffiths has just reminded me that we have done exactly what Mr. Newton suggests, that we have placed to the credit of the reserve fund the income from the reserve fund during the year.

Sir JAMES ANDERSON: Mr. Newton wants the opposite.

The CHAIRMAN: Well, I think that is the most direct way of dealing with it; and you are a very good accountant, Mr. Newton, I know. We are, however, always open here to learn anything you can show us; and I will put you in contact with our accountant, Mr. Griffiths, and if you can convince him I don't think there will be much difficulty in convincing us.

Mr. SHERWIN: Those accountants are more or less the servants of the Company, and I do not think we should be thrown back upon them. I think the revenue might fairly be increased by carrying the interest from the investments of our reserve fund to the revenue account. I think we might fairly say that for the future the dividend on the invested reserve fund should be carried, as suggested by Mr. Newton, to the credit of the revenue account.

The CHAIRMAN: Our capital is over five and a half millions, and I think our reserve fund is far short of what it ought to be [hear, hear]; and therefore I am not prepared to make any departure from the policy we have established. I will give you a case in point. A gentleman has asked me now in regard to the Direct Spanish Company. We thought it desirable to get some control over that company. We purchased a certain number of their shares to get that control, and we placed upon the Board Sir James Anderson and another member of our Board, so as to look into affairs carefully. They found on examination that the reserve fund there was practically gone, and that there was no reserve fund to enable them to restore the cable. What has been the consequence? They have been obliged to suspend interest on the preference shares, because if they were to go on paying interest on those preference shares they might find the cable broken without a shilling in the locker to repair it.

Mr. NEWTON: I am afraid you have associated my name with a question I do not approve of. I approve of your increasing the reserve fund to a million, but I cannot approve of your not regarding that as the shareholders' capital. You may call it what you like, but I regard it as belonging to the shareholders. The question that I have raised is that all our revenue should come through the revenue account. All that I want is for it to be seen that we are doing so well as we are.

The CHAIRMAN: As I told you, it is entirely a matter of book-keeping, and if you can convince Mr. Griffiths you will not have much difficulty in convincing us. I think I have now answered all the questions, and I will put the resolution.

A SHAREHOLDER: I think the question whether you derive any dividend from the Direct Spanish Company has not been answered.

The CHAIRMAN: There is no dividend on the shares.

The SHAREHOLDER: Is there any dividend on the debentures?

Sir JAMES ANDERSON: Six per cent.

The CHAIRMAN: Six per cent. [He then put the motion for the adoption of the report in the usual manner and declared it carried unanimously.]

The VICE-CHAIRMAN (the Marquis Tweeddale): I have much pleasure in moving the next resolution, which is as follows:—"That John Pender, Esq., M.P., who now retires, be and is hereby re-elected a Director of the Company."

Mr. GEO. GARDEN NICOL: I beg to second it.

The VICE-CHAIRMAN put the motion and declared it was carried.

The CHAIRMAN: I am very much obliged to you for this further proof of your confidence. I think, taking all things together, from the beginning up to the present time, we may congratulate ourselves in being associated with a very prosperous company, and one which is likely to be still more prosperous. The next resolution is, "That the Most Honourable the Marquis of Tweeddale, who now retires, be and is hereby re-elected a Director of the Company."

Sir JAMES ANDERSON: I have much pleasure in seconding it.

The CHAIRMAN put the motion, which was carried.

The MARQUIS OF TWEEDDALE: I beg to thank you for the honour you have done me.

Major LESLIE: Mr. Chairman and gentlemen, I have much pleasure in proposing the re-election of our auditors, Mr. Henry Dever and Messrs. Quilter, Ball, and Co., and I trust that they will always have so good an account to render us as on the present occasion.

Mr. GIBB: I beg to second that.

The CHAIRMAN: The motion is, "That Mr. Henry Dever and the firm of Messrs. Quilter, Ball, Crosbie, Glegg, and Welton be, and are hereby elected auditors of the Company for the current year, with a remuneration of £100 each. [He put the motion, and declared it carried unanimously.] I think, gentlemen, that closes the business of the meeting.

Mr. GIBB (a shareholder): I rise to propose the usual vote of thanks to the Chairman, Directors, and staff for their services. We may congratulate ourselves on having such a good account.

Mr. GRIFFITHS: I beg to second that. The public reputation in which our Company stands is greatly due to the able conduct of the gentlemen who have managed the affairs of the Company during the past half year. At this late moment I will not detain you, but I am sure the very courteous replies given by the Chairman and the full explanation he has afforded must convince you that he is entitled to the gratitude of those for whom he has laboured so hard.

The SOLICITOR (Mr. Burt) put the motion and declared it carried unanimously.

The CHAIRMAN: On behalf of myself and colleagues I have to thank you for this renewed evidence of your confidence.

The proceedings then terminated.

PHYSICAL SOCIETY.—January 24.

Professor Guthrie, President, in the chair.

Messrs. J. Rose Innes, A. Howard, and A. M. Worthington were elected members of the society. Some "Lecture Experiments on Spectrum Analysis" were shown by Mr. E. CLEMENSHAW. The chief point in these experiments was the production of a brilliant light without the use of the electric arc. A small quantity of a solution of the salt to be experimented on is put into a flask, in which hydrogen is being evolved by the action of zinc upon dilute sulphuric or hydrochloric acid. The bottle is provided with three necks, one being fitted with an acid funnel, one with a jet, and by the other is introduced a current of coal gas, or better, of hydrogen, by which the size of the flame can be increased and regulated. The jet, which is about one-eighth of an inch diameter, is surrounded by a larger tube by which oxygen is admitted to the flame, the result being a brilliant light giving the spectrum of the substance, which is carried over mechanically by evolved hydrogen. The spectra of sodium, lithium, and strontium were shown upon the screen; and the absorption of the sodium light by a Bunsen flame containing sodium was clearly seen.

An instrument to illustrate the conditions of equilibrium of three forces acting at a point was exhibited by Mr. WALTER BAILY. This instrument consists of a circular disc of soft wood, from the back of which an axle projects. The disc is provided with a graduated circle, and its centre marked by the intersection of two fine lines upon a small mirror. Three compound threads, each consisting of two threads connected by a short piece of elastic, are knotted together, the free end of each being fastened to a pin. Two of these pins are stuck into the disc at such a distance from the centre that the knotted ends cannot reach the centre without stretching each thread, and the remaining pin is then adjusted so that this condition is fulfilled. There are now three forces in equilibrium acting at the knot. The angles between their directions are obtained from the leadings of the graduated circle where it is crossed by the threads. To determine the magnitude of these forces the axle of the disc is held horizontally and turned till a thread is vertical, the pin is then removed, a scale-pan attached to the end of the thread, and weights added till the knot is brought back to the centre. This is repeated with the other threads. It was found possible to show the proportionality of the forces to the lines of the opposite angles with an error not exceeding one per cent.

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THE EASTERN TELEGRAPH COMPANY'S SYSTEM, with Connections.

From	To	Miles.	Date.
Portheurno	Lisbon	846	1870
do.	Vigo	622	1873
Vigo	Caminha	36	1876
do.	Lisbon	264	1873
Belem Cables	No. 1 four cores	1	
do.	No. 2 ,, ,,	1	
do.	No. 3 six cores	1	
Lisbon	Gibraltar	368	1870
Villa Real	Gibraltar	155	1871
Gibraltar	Malta	1118	1870
Malta	Pozzallo	54	1869
Sts. Messina			
,, Faro	Bagnara, 3 cores	8	1884
,, Ganzirri	Cannitello, 2 ,,	3	1874
,, ,,	,, 3 ,,	2	1881
,, ,,	,, 3 ,,	3	March 1883
,, ,,	,, 3 ,,	2	Nov. 1883
Marseilles	Bona, No. 1	448	1870
Marseilles	Bona, No. 2	463	1877
Bona	Malta, No. 1	380	1870
Bona	Malta, No. 2	384	1877
Malta	Tripoli	204	1882
Malta	Alexandria, No. 1.	925	1868
Malta	Alexandria, No. 2.	914	1870
Alexandria	Larnaca	328	1878
Alexandria	Port Said	153	1882
Suez	Suakim	931	1884
Suakim	Perim	588	1884
Perim	Aden	104	1884
Suez	Aden, No. 2	1445	1876
Suez	Aden, No. 3	1402	1883
Aden	Bombay, No. 1	1829	1870
Aden	Bombay, No. 2	1889	1877
Trieste	Corfu	503	1882
Otranto	Corfu	84	1861
Otranto	Zante	187	1874
Corfu	Zante	172	1871
Zante	Canea	245	1873
Canea	Candia	74	1871
Candia	Syra	134	1878
Candia	Sitia	56	1871
Sitia	Rhodes	145	1871
Sitia	Alexandria	360	1873
Zante	Katakolo	27	1884
Zante	Patras	57	1884
Patras	Corinth	68	1884
Kalamaki	Piraeus	31	1884
Piraeus	Syra	81	1884
Syra	Khios	96	1873
Khios	Tchesme	10	1871
Khios	Tenedos	97	1878
Tenedos	Lemnos	58	1884
Lemnos	Salonica	140	1884
Tenedos	Chanak	32	1878
Chanak	Kartal	145	1878
Rumilie Hissar	Anatolie Hissar (3 cores)	1	1878
		18,674	

Cables leased by Eastern Telegraph Company to the Greek Government.

From	To	Miles.	Date.
Corfu	Paxo	12	1884
Corfu	Sta. Maura	43	1884
Sta. Maura	Ithaca	7	1870
Ithaca	Cephalonia	7	1869
Cephalonia	Zante	18	1871
Rio	Anderio	1	
Zante	Trepito	11	1870
Morea (Peloponnesus)	Cerigo	10	1881
Morea do.	Spezzia	½	1873
Morea do.	Hydra	5	1873
Morea do.	Poros	⅙	1873
Poros	Methana	4	1884
Methana	Ægina	4	1884
Ægina	Piræus	12	1884
Salamis	Daphne	4	1884
Laurium	Zea	16	1884
Zea	Thermia (Kythnos)	9	1884
Thermia (Kythnos)	Seripho	15	1884
Seripho	Siphano	11	1884
Siphano	Milo	20	1884
Siphano	Paros	22	1884
Paros	Naxos	5	1884
Naxos	Amorgo	23	1884
Naxos	Nio	13	1884
Nio	Santorin	13	1884
Paros	Syra	24	1884
Syra	Tinos	12	1873
Tinos	Mykoni	6	1884
Mykoni	Rhenea (Delos)	5	1884
Tinos	Andros	2	1873
Andros	Eubœa	9	1873
Eubœa	Petali	2	1869
Eubœa	Attica	13	1879
Bridge of	Eubœa, No. 1	1/212	
Bridge of	Eubœa, No. 2	¼	1884
Eubœa	Cape Stavro	4	1881
Eubœa	Skiathos	8	1881
Skiathos	Skopelos	8	1884
Trikiri	Vathi	5	1884
Projected. Salamis	St. Georges	1	
Eubœa	Skyros	24	
Anaphi	Santorin	14	
Rio	Sikino	8	
Sikino	Polykandro	8	
Lixuri	Cephalonia	8	
		447	

The Eastern Telegraph Company's Land Lines.

From	To	Miles.
Aërial.		
Leased from Post Office. London	Penzance, 1	305
do.	do. 2	305
do.	Liverpool	250
Liverpool	Manchester	33
do.	Glasgow	229
London	Havre and Marseilles	690
(Cable & Land Lines leased from French Govt. and Sub. Coy.)		
Penzance	Portheurno	33
Alexandria	Suez (Double Line)	452
Alexandria	Cairo(do.)	274
Suez	Cairo	152
Port Said	Suez, 1	96
do.	do. 2	96
Otranto, C.H.	Office	2
Greek	(Land Lines)	53
Candia	do.	164
Cyprus	do.	168
Subterranean.		
Vigo C.H.	Office	2
Caminha ,,	,, ,,	3
Lisbon ,,	,, ,,	2
Gibraltar ,,	,, ,,	4
Marseilles ,,	,, ,,	3
Bona ,,	,, ,,	2
Malta ,,	,, ,,	19
Tripoli ,,	,, ,,	2
Zante ,,	,, ,,	2
Suez ,,	,, ,,	2
Bombay ,,	,, ,,	2
	Total	3345

The Eastern and South African Telegraph Company's Cables.

From	To	Miles.	Date.
Aden	Zanzibar	1909	1879
Zanzibar	Mozambique	640	,,
Mozambique	Delagoa	970	,,
Delagoa	Durban	345	,,
	Total	3864	

Land Lines..... 6½ miles.

The Black Sea Telegraph Company's Cable.

From	To	Miles.	Date.
Kilia	Odessa	351	1874

Land Lines..... 27 miles.

The Eastern Extension Telegraph Company's Cables.

From	To	Miles.	Date.
Madras	Penang	1455	1870
Penang	Rangoon	860	1877
Penang	Singapore	414	1870
Penang	Malacca	275	1879
Malacca	Singapore	116	1879
Singapore	Saigon	620	1871
Saigon	Hong Kong	979	1871
Saigon	Thuan, An (Hué)	516	1883
Thuan, An.	Haiphong (Tonquin)	271	1883
Haiphong	Hong Kong	464	1884
Hong Kong	Macao	38	1884
Hong Kong	Bolinao (Luzon)	529	1880
Hong Kong	Foochou	475	1883
Foochou	Shanghai	445	1883
Singapore	Batavia	539	1870
Singapore	Banjœwanji	920	1879
Banjœwanji	Port Darwin, No. 1	1104	1871
do.	do. ,, 2	1129	1879
Flinders	Lowhead	180	1869
Sydney	Nelson, N.Z.	1283	1876
	Total	12,612	

Subterranean Cable Land Lines ..... 24 miles.

SUMMARY:

CABLES.

	Miles.
Eastern Telegraph Company's	19,121
Eastern and South African Company's	3,864
Black Sea Telegraph Company's	351
Eastern Extension Company's	12,612
Total Length of Cables	35,948

LAND LINES.

	Miles.
Eastern Telegraph Company's	3,345
Eastern and South African Company's	6½
Black Sea Telegraph Company's	27
Eastern Extension Company's	24
Total Length of Land Lines	3,402½

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The Anglo-American Brush Electric Light Corporation.

The ordinary general meeting of this Corporation was held at the Cannon-street Hotel on the 4th inst., under the presidency of the Right Hon. Lord Thurlow.

The SECRETARY (Mr. Emile Garcke) having read the notice convening the meeting,

The CHAIRMAN said it was a great pleasure to him and, he thought, to all his colleagues, to be able to meet the shareholders on that occasion under, what he hoped they would all admit, were certainly more favourable circumstances than those which existed a year ago. The present year had undoubtedly been one of many vicissitudes, not all of them of a very pleasant nature. Trade certainly had not revived to the extent that was anticipated, and all commercial interests had necessarily suffered more or less from this cause. It was not to be expected that a new industry like electric lighting could have formed any exception to this rule ; nor had it done so. The fact was that people were waiting for better days before they embarked in what would at first entail a large outlay for capital account. He thought if they took all these circumstances into consideration they would consider that the business transacted by the Company this year had not been altogether of an unsatisfactory nature. They had held their own as well as any of their rivals and competitors. They began the new year with important machines, with increased economy in the manufacture, and with widely extended appreciation both on the part of the public and of the Government, and especially the Admiralty, for whom they had executed and were executing important orders. He thought, therefore, that he might say that they began the new year under very favourable auspices. In addition, they must remember that the Company's shops were still full of remunerative work, and that they had by no means an unimportant balance at their bankers. Apart from manufacturing improvements and details, he thought it would be admitted that the two salient features in the Company's policy last year had been, first, the further concentration under one roof of all the operations that were necessary in the construction of dynamos and lamps, which hitherto were scattered throughout different buildings several miles apart. The result of these removals had naturally been a complete reorganisation of all their machinery and a very great saving had accrued both in labour and steam power. In doing this they had had to enter into a very careful analysis and re-valuation of all their plant, which had been done by very competent people, with the result that it enabled them to transfer a great deal of machinery which had now become superfluous to stock account, from which it could be taken and re-established in the works or disposed of as favourable opportunities might occur. The second salient point in their policy, he maintained, had been the progress they had made in absorbing the subsidiary companies. In his mind there could be no question that the original policy of the Corporation in founding subsidiary companies was an eminently sound one. Nothing, he thought, could have been sounder than to have had substantial local companies to work the provinces and the metropolis, and become the best customers of the great central manufacturing Corporation. But that dream was not destined to be realised ; and as a matter of fact, the reason for the existence of the subsidiary companies passed away almost as rapidly as it had arisen. Under these circumstances, he maintained that the policy the Corporation were pursuing in absorbing all these companies as opportunities might offer on terms favourable to all concerned was at once the most generous and most judicious. The report stated that they had come to terms with and had absorbed the Great Western and the Brush Midland Companies. The terms made were eminently satisfactory to all parties concerned. The conditions of amalgamation or absorption were not arrived at without lengthy discussion and careful consideration, and he thought he might say without making concessions on both sides. The Corporation had acquired by these amalgamations, besides cash, very valuable assets, important opportunities of extending their manufacture and sales. They had also recovered for a sum just under £6,000 their licenses over 23 counties in England and Wales, for which the Corporation received previously £27,730 in cash. This £6,000, too, would be paid in shares by the Corporation. The exact amount of new capital they would be called upon to create could not be quite accurately stated. It would depend on circumstances which he need not enter into, but there could be no doubt that the total amount of issue would be considerably short of the maximum mentioned in the report. On this new capital they would have to look to pay dividend, but it would be in a good dividend year, he maintained, an additional charge which would not be felt, and in a bad dividend year it would certainly be unimportant. With regard to paragraph 8 in the report—which he considered second to none in importance—it dealt with the steps they had taken and were taking to procure a complete revision of the Electric Lighting Act of 1882. The intention to ask the Government to review an Act so recently passed was an undertaking of considerable magnitude, but he was sanguine of success, as they had public opinion on their side. They had been met very frankly by the Edison-Swan Company, by Mr. Hammond, and Mr. Crompton—in fact, by all the leading men connected with electric lighting. They had set aside any differences they might have had, and had made common cause to obtain the removal of the fetters of 1882. The Act of 1882, he thought, must be cautiously approached. There was no doubt in his mind whatever that the provisions it contained acted most prejudicially and most unfairly on this new industry. At the same time, he was one of those who thought and believed that when the Act was passed its authors were really anxious to encourage the new industry. None the less was he one of those who held that on that occasion Parliament mistook its duty, which certainly was to have fostered by every means in its power, and not to have throttled a new discovery, which was destined to confer such benefits on mankind, and he thought their best chance of arriving at a satisfactory conclusion was to argue the question with calmness and without passion. They must remember the circumstances under which the Act of 1882 was passed. The science was in its infancy. The only thing that was patent to the public and the Legislature was the rash gambling spirit that prevailed at the time, and which the Legislature naturally deemed it its duty to curb and discourage to the utmost extent. In looking back to that time he could not help feeling that the attempt made to frame an Act which should not require amendment, and which should be adaptable to the advancement of science, as these improvements should be made, was almost superhuman, and it could not be wondered at that it had failed. He thought, as regarded this Act, that so far from giving rise to the recriminations and aspersions which were so freely cast upon it, it would in due time take its place amidst those pioneers of legislation of which the British Parliament had produced so many examples. Strong in their conviction, they approached Mr. Chamberlain, who received them not merely courteously, but with an evident desire to lend an unprejudiced ear to what they had to say. They had the good fortune to get their case stated by Sir Frederick Bramwell, and finally they were requested by Mr. Chamberlain to draft clauses of amendments for the consideration of the Board of Trade. They were still engaged in that task, with the assistance of Sir Frederick Bramwell and many other distinguished men, and he for one looked forward with confidence to the recognition of the justice of their demands, and to the removal of what certainly were the most onerous conditions ever imposed on the application of capital to a British industry. As to the financial condition of the Company, the year's work had shown a gross manufacturing profit of about, in round figures, £23,000. Of that sum £16,723 were absolutely on manufacturing account, and he desired to say that that figure had been made the subject of a careful scrutiny both by themselves at the Board, by their accountant, and by their auditor, and it might be relied upon as substantially correct. The other figure of £6,000 odd, which appeared in the accounts as other receipts, as sundry profits other than gross profits on trading—that figure represented items of what, perhaps, other companies might consider of an unusual character. But they were items fairly belonging to the revenue account, and one of his reasons for saying so and insisting upon the point was that they were items which, in a concern like theirs, would recur, and must recur, year after year, to a greater or lesser extent. They belonged distinctly to revenue and not to capital. And this gross total of £23,000 of profits would have been much larger by many thousands of pounds had it not been for an unfortunate falling off in orders which occurred during the summer months of 1884. Their net profit after deducting the standing charges and other things that had to be taken out of this sum stood at £5,743. This would have been larger by £2,000 had it not been for the proverbial uncertainty of the law, which was strikingly exemplified in the Muir law suit—a case which they would remember was one very unfortunate to them all as shareholders—but it was a case for which the present management was not responsible. The former management ordered of that firm a most unwieldy and extravagant machine. It was contracted for to be supplied in eight or nine weeks. It was not ready to be delivered for nine months, and it was not till greatly after that time that it was delivered. No wonder, therefore, that when the new Board found they did not want this machine they refused to take delivery of it. The thing went into the law courts, and the Corporation got several decisions in their favour, but owing to the uncertainty of the law, to which he had alluded, the final decision had been given against them. He would not have referred to this subject had he not desired to say that no item of that kind could enter into the accounts of 1885, as all the law charges for 1884 had been fully met and provided for, and they stood not only free from all litigation, but he believed (it was a rash thing to predict) without any chance of any appeal against any decision given heretofore in favour of the Corporation. Whatever litigation, therefore, which might be in store for them in 1885 would be honestly incurred in that year. The first duty of course in appropriating a financial margin was, as the shareholders were aware, to clear off an adverse balance if they unfortunately had one of the year before, and their accountant had done so in this balance-sheet. He left it not as a matter of option, but as a matter of necessity, and that reduced the sum they were called upon that day to appropriate to £4,127. That sum would be sufficient to enable them to declare a dividend at the rate of 2½ per cent. on the paid-up capital of the Corporation for the past twelve months if they desired to do so. That, however, was not a course which the Directors recommended for their adoption. They advocated the course sketched in the printed account attached to the balance-sheet, namely, to write off £1,500 from patents account, to write off £1,000 from goodwill and licenses recovered over twenty-eight counties in England and Wales, and to carry forward the balance of £1,627 to the credit of the ensuing year. They felt sure that that was a course which would give confidence to all, and would be acceptable to the great body of shareholders, and they also felt that it was a course that would be most consistent with the real interests of the Corporation. At the same time he did not wish them to lose sight of the fact of their having turned and returned to the position of a dividend earning Corporation. He trusted they would support the suggestion in the report of electing Mr. Braithwaite as a director of the Company. That gentleman was formerly chairman of the Great Western Electric Light Company, and he took, and always had taken, a great interest in electric lighting, and he was eminently qualified for the position of a director of the Corporation. He eulogised the services of the staff, referring in particular to the eminent services of the general manager and engineer (Mr. Frank Wynne) and of the secretary. Since he had been in the room a little piece of paper had been handed up to him, which he thought they would admit was of an encouraging character. It could not fail to be encouraging, being, as it were, a straw which showed which way the wind blew. He heard that one of the first

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and most successful English gas companies (the name of which he was not at liberty to mention) had asked for powers to raise £300,000, which was to be used for electric light purposes. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (Mr. John Scudamore Sellon) seconded the motion, remarking that, after the supplementary explanation given by Lord Thurlow, there was very little left for him to say beyond emphasising, as he earnestly wished to do, what had often been foreshadowed, namely, that with the advance of the electric light which was inevitable now that its advantages and practicability were realised, and with the prospect that the ever-to-be-condemned Electric Lighting Act of 1882 would be remodelled upon lines of intelligence and justice, the property of the Corporation would stand out well in the foreground as embodying certainly the three great essentials to success, namely a good and well proved system, the highest class of workmanship, and a most excellent executive staff. The Board had had uphill work to arrive at the present condition of things, but he could now with confidence ask them to feel that if there was success in this important branch of industrial work and scientific development the Corporation would both deserve and command it.

Mr. W. ABBOTT referred to the expenses, which he thought were heavy, in obtaining the results arrived at.

Mr. F. W. REYNOLDS trusted that no new patents had been acquired, and he thought, if they did acquire any patents the payments should be by way of royalty. On the whole, he thought the balance sheet very satisfactory, but he thought there was not the slightest chance of the electric light making any great progress until there was some improvement in the general volume of business of the country.

Mr. HALL generally concurred with the remarks of Mr. Abbott. He thought that certain accounts included in the present year should have been included in the last year, as there was no use in endeavouring to make bad look better.

The CHAIRMAN, in reply, said that Mr. Abbott had scarcely been fair in his remarks as to the expenses. As a matter of fact, the total charges for 1884 had been £14,693, as against £26,533 last year, showing a diminution of the total normal charges in one year of 45 per cent. He certainly did not consider that a trifling matter. He mentioned various economies which had been effected, and said that there had been an increase of 120 per cent. in the volume of their work for the previous year. They had not acquired outside their works any more patent property last year, and the increased charge which was referred to in that item was for the cost of the developments and improvements made in their own works in connection principally with the new armature, which was of such enormous advantage to them, and which had achieved such excellent results. They had also been at some expense in improving the ratchet lamp. As to paying an interim dividend he would be the first one to hail such a proposition with delight, and if things went on well there was no reason why there should not be one. This was a matter, however, which rested with the public and the success of their endeavours to obtain legislative relief in the Act of 1882.

The motion was unanimously adopted, and resolutions were afterwards passed re-electing Mr. H. C. Gibbs, Mr. J. I. Courtenay, and Mr. Wm. Ladd, F.R.A.S., to their seats at the Board; appointing Mr. J. B. Braithwaite, jun., a Director; and re-electing Messrs. Cooper Brothers and Co. Auditors.

On the motion of Mr. ABBOTT, a vote of thanks was passed to the Chairman, and the proceedings then terminated.

South African Brush Electric Light and Power Company (Limited).

A general meeting of this Company was held on Wednesday at the City Terminus Hotel, Cannon-street, Lieut.-Colonel G. Coxon in the chair, for the purpose of receiving the audited balance-sheet of the Company, made up to the 28th of January, 1885.

In opening the proceedings,

The CHAIRMAN said the Directors did not think it was necessary for them to print the accounts. They had been made up to the latest possible date, had been duly audited, and were on the table for inspection by any of the shareholders. What he might term the "cream" of the document lay in a few items, which he would quote to the proprietors. In the first place, they had £10,683 4s. 2d. at the bank, a bill due on the 13th of June, 1885, amounting to £1,500, and there was an outstanding account with the Town Council of Kimberley, which, he might add, was undisputed, amounting to £1,680. The Directors had instructed their representative to recover the sum, and they expected very shortly to hear of it having been paid. In addition to this, there were sundries amounting to £235, making the gross assets £14,098 0s. 2d. The debts included the estimate of expenses up to the end of the 28th June, £494 5s. 1d.; in assets for distribution, less, of course, the expenses of liquidation, £13,603 19s. 1d., which would run to about 14s. per share.

The meeting having been made special,

The CHAIRMAN proposed the following resolution:—"That the Company be wound up voluntarily under the provisions of the Companies Acts.

Mr. T. DICKSON seconded this, and it was agreed to, whereupon,

The CHAIRMAN proposed the appointment of Mr. T. J. Seel (the Secretary) as sole liquidator, with all the power which could be conferred on a liquidator under the Companies Acts, with a fee of 100 guineas. He said he thought that gentleman was so well known to all the shareholders that his proposal required very little apology from him. He alluded to the great difficulties Mr. Seel had had to contend with, and said he thought they were very much indebted to him for the manner in which he had conducted the business placed in his hands.

Mr. PORTER RHODES second the resolution.

Mr. DICKSON said he was sorry to have to differ from his colleagues. He had had considerable experience as a liquidator, and he was of opinion that the liquidation should be conducted by a gentleman who had a substantial interest in the undertaking. The Secretary was not a shareholder, and did not represent the interest of the Company, as would a gentleman who held shares. There was no means of telling what might crop up during the liquidation. They might think it was all plain sailing, but they might be mistaken. He thought a member of the Board should have the appointment, at the same time reminding the shareholders that directly a liquidator was appointed they parted with their "personality" altogether.

Replying to questions asked,

The CHAIRMAN said they were not entirely clear of the parent company, inasmuch as in assigning to Kimberley and Cape Town the patents they had unfortunately done so without assigning the responsibility which still attached to them. The parent company would still consider them responsible for any shortcomings of the Company to which they had assigned the patents; but they had no reason to believe that the parent company would be unreasonable in these matters.

The resolution was then carried subject to confirmation fourteen days from the date of the present meeting.

In thanking the proprietors for having appointed him, Mr. SEEL said it would be his duty as soon as the resolution was confirmed to distribute the assets amongst them as speedily as possible. He saw no reason why the distribution and dissolution of the Company should not be speedily effected; indeed, the distribution to the shareholders should certainly take place within three months of the confirmation of the motion.

A vote of thanks was passed to the Chairman, and the proceedings terminated.

KING'S COLLEGE ENGINEERING SOCIETY.

On Tuesday last, at an evening meeting of this society, Professor W. G. Adams, F.R.S., gave a lecture on "The Electrical Experiments at the South Foreland," of which the following is an abstract. The lecturer said:—

A person walking from Deal to Dover would find when he approached St. Margaret's Bay that besides the two permanent lighthouses of the South Foreland there were three other towers, or tall windmills of singular construction without their sails, labelled A, B, and C, as though they were intended to teach the alphabet to some giant race. These towers are three experimental lighthouses for testing the several modes of lighthouse illumination. The "A" tower is designed to give the light of the electric arc on one or more of three tiers or stages, one above another. The "B" tower gives the gas light according to the system of Mr. Wigham, on four stages; and the "C" tower is supplied with oil lights, and sometimes with gas lights, on the system of Sir J. Douglass, on three several stages. The lights are spoken of as single, biform, triform, or quadriform, according as one or more of the stages of a tower supply light at the same time. Thus the light from all three stages at once of the "C" tower when supplied from oil would be described shortly as "triform" oil, known as the high and low light. The two permanent lighthouses, about 450 yards apart, have been supplied with the electric current since 1869 from Holmes' magneto-electric machines. In clear weather one machine is usually employed for each light, the second machine being ready for use in case of accident or in foggy weather. The machine contains 48 compound horse-shoe magnets, each weighing 44lb., arranged in circles with their poles toward the centre in seven vertical planes. There are 96 helices or coils of copper wire fixed on six wheels, which revolve so that the coils pass in front of the poles of the magnets—*i.e.*, between the poles of parallel rings of magnets. The ends of the wires of the several helices are joined alternately to two cylinders of metal or collectors on the axes against which the brushes rub which take the current to the external circuit. As a coil passes from a south pole to a north pole there is a current in it in one direction which is reversed as the coil goes from a north pole to a south pole, so that in one revolution there are sixteen reversals of the current, and the machines are driven at 400 revolutions per minute. Each machine absorbs about 3·2 horse-power, and with a mean electromotive force of 29 volts supplies a mean current of about 28 amperes and gives a light of about 1,520 candles. The E.M.F. on open circuit is about 75 volts. Two Holmes machines when joined to the same external circuit with a mean E.M.F. of 31 volts will supply a mean current of 53 amperes. Regarding the product of these numbers as the average power of the machine, we get 1,640 watts or units of power from the two machines to 3,000 candles. This is the permanent arrangement at the South Foreland for lighting shipping in the Channel. The 1,500 candle-power light is intensified by lenses and by prisms, and gives horizontal belts of light extending over the sea for a considerable arc, the high light illuminating about 180 degrees of arc. The engine room, in which the magneto machines are placed, is about half way between the two permanent lighthouses. The chief interest of the experiments which have been lately carried on is gathered round the three experimental towers, A, B, and C, for here are found the largest and most brilliant lights, whether electric, gas, or oil, which have ever been employed for lighthouse purposes, and as you may have seen occasionally in the daily papers between two of them the rivalry is very keen. The object of these measurements is to determine the brilliancy and the best arrangement of these lights, their efficiency, and the cost of their production. For the measurement of the lights themselves, without the lenses, a photometric gallery, some 400ft. in length, has been built on the

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cliff, near the engine room. This is supplied with gas from temporary gas works on the cliff, and with electric current by leading wires from the engine room, in which all the magneto machines are placed.

Professor Adams then proceeded to describe the methods of measuring several lights by means of the Bunsen disc and the star disc photometers, and also by the shadow photometer, taking for the standard a Douglass lamp with colza oil, and with a slit of given size used, called the Merthven slit, from which measurements are taken. The Bunsen disc and shadow of photometer are fairly suitable for oil and gas lights, but when we come to the electric light, it is found blue in comparison with the yellow light of gas or of the 6-wick oil light. Experiments were then made to determine the illumination given by the electric light by means of a dispersion photometer, using a convex lens as in the method proposed by Dr. Hopkinson, by which it was shown that within a distance of 10 feet of the electric arc, giving a light of 16,000 or 20,000 candles, the light may be compared with an ordinary standard of one or two candles, the difficulty arising from difference of colour being got rid of by using ruby glass and other coloured glass, or solutions such as ammonia sulphate of copper, in front of the eye of the observer of the Bunsen disc, to determine how much red or how much yellow or green or blue light is present in the light of the electric arc as compared with the amount of the same kind of light present in the standard of light chosen for comparison with it.

General Description of Lighthouse Arrangements.—Taking the various kinds of light in their chronological order, we have first the oil lamp, which, in its present improved state, consists of a number of concentric burners, with wicks arranged as in the duplex lamp, the number of wicks varying from 1 to 6, and in some recent lamps to 7 and 8. The flame of the 6-wick lamp, which is commonly used, is contracted by means of a properly curved glass chimney to 4·33in. in diameter, at the level of the centre of the lens, which sends out a slightly divergent beam to the horizon. The horizontal divergence of the beam amounts to about 6°, when the centre of the light is placed accurately in the focus of the lens. The light given by the 6-wick burner, from measurements made at the South Foreland, will probably be found to be about 800 candles. In consequence of the small divergence of this beam, it will give a light at some distance on the sea equal to the illumination from a source of 2,000 candles where there is little more than twice the same divergence. The Wigham gas burners consist of a number of separate gas burners arranged in rings and put on in sections with open spaces between for the supply of air. Imagine a number of seperate burners on one arm bent into the arc of a portion of a circle, and these supplied ring after ring, the inner being slightly raised above the outer rings, and you have the Wigham arrangement of gas burners. Beginning from 28 jets for the lowest light required, increased illumination is obtained by adding outer rings of jets by 20 at a time up to 108, which give a breadth to the gas flame of 11 inches at the level of the lens. Hence the light from this burner is greatly scattered, and the horizontal divergence of the beam from the lens was found to be over 14 degrees. The light given by the 108 jet gas burner, as measured at the S. Foreland, will probably be found to be about 2,000 candles.

We now take the electric light as given forth from the "A" Tower. The current is generated by alternate current magneto machines of the largest type made by De Meritens, having 60 permanent magnets arranged in five rings of 12 magnets and 24 coils of each ring of the revolving armature.* After describing the method of measuring E.M.F. (1) by the electrometer (2) by Cardew's voltmeter, and the current by a Siemens electro-dynamometer (a fuller description of which will also be found in the number of *The Electrician* just referred to), continuing, the lecturer pointed out the influence of high resistance on the distribution of electrical energy in the circuit. That, whereas only an E.M.F. of 30 volts is required at the extremities of the arc, the E.M.F. at the machines is increased to 45 and even 50 volts with a corresponding diminution of current in consequence of the high resistance of the leads to the tower 300 yards away. Thus the current of 220 or 230 amperes, which can be obtained through an arc from one De Meritens machine is reduced to 130 amperes, and on employing two machines in parallel circuit for one arc the current is reduced from more than 400 amperes to about 180 amperes. In spite of this, the electric energy from the De Meritens machine is about ten times the electric energy from the Holmes machine, with a corresponding increase in the light given forth from the arc. From the arc from one machine an illumination of about 16,000 candles may be obtained, and from two machines from 20,000 to 30,000 candles, the machines sometimes being used to supply a single arc, and sometimes two arcs in series in the biform arrangement of the lights. The various experiments of 19th July, 1884, were then described, when, for the first time, two alternate current machines were set running together with their brushes united, and then the belt thrown off one machine, which continued to be driven as a motor by the current from the other machine. A full description of these experiments will be found in our issues of December 6 and 13.

* Further description of these machines will be found in our issue of 6th December, pages 75–76.

TRAFFIC RECEIPTS FOR JANUARY, 1885.

COMPANIES.	Jan., 1885.	Jan., 1884.	Increase.	Decrease.
Cuba Submarine	3,000	3,009	—	9
Direct Spanish Telegraph ..	1,770	2,072	—	302
Direct United States	—	—	—	—
Eastern Extension	44,144	41,129	3,015	—
Eastern Telegraph	57,249	55,503	1,746	—
Submarine	—	—	—	—

THE DRAWBAUGH TELEPHONE CASE.

AMERICAN BELL TELEPHONE COMPANY AGAINST THE PEOPLE'S TELEPHONE COMPANY ET AL.

(CONTINUED FROM PAGE 192.)

The third class of witnesses are those who identify more or less positively one or more of the several exhibits as the instruments used by them or which they saw used by others prior to March 7, 1876. Exhibits F and B are identified by the following witnesses:—Brooks saw them in 1874; Smyser, in 1872; Eberley, before Dec., 1870; Wagner, in the fall of 1874; Freese, in 1869 or 1870; Yetter, about Christmas, 1875; Fry, spring of 1875; Carl, in 1870; Scherick, in 1869; Balsley, between 1870 and 1874; Good, before 1872; Kahey, in 1871 or 1872; Schettel, about 1872; Nichols, in 1875; Renneher, in May, 1875; Weber, late in 1874; Stephen, before 1875; Shireman, about 1872; Hawn, about 1872; H. B. Eberly, in May, 1873; J. C. Smith, between April, 1872, and April, 1873; Sternberger, in October, 1871; Fetterow, in April, 1876; Halsinger, prior to 1876; Shoop, in 1869; H. F. Drawbaugh, in 1872; Zimmerman, in 1871; Bates, in 1874; Guistwent, in July, 1870; Hale, in fall of 1873; Stone, in June, 1871; Free, in June, 1872; J. A. Oyster, in June, 1875; Harman K. Drawbaugh, in July, 1871; J. B. Drawbaugh, in 1869; G. W. Drawbaugh, in 1870; Lenseman, in July, 1881; Fisher, in 1868 or 1869; Hubler, in fall of 1873; Updegraff, in 1874; W. H. Decker, in 1873; and a number of other witnesses saw one of these two exhibits.

The identification of Exhibits C, I, and A is made by a smaller number of witnesses. Some of them think they saw C in 1870 and others at various dates after that, and as late as March, 1876.

One of the witnesses thinks he saw I in 1871, the others locate the occasions in 1873, 1874, and 1875. Some of the witnesses think they saw A as early as 1872, one of them in 1870, but most of them saw it, they think, in 1875.

Exhibits E and D resemble each other very closely in appearance, and most of the witnesses produced to identify them saw both at the same time. They locate the time as follows:—Fry, labourer, in May or June, 1875; Fry, farmer, in April, 1875; Bayler, in June, 1873 (Ex. D); Springer, after April, 1876; Shettel, about 1875; Shoop, after February, 1877; Musser, in June, 1876 (Ex. D); Milliard, in 1875; Holsinger, in summer of 1875; Shoop, in 1874 or 1875; Bates, between 1874 and 1877; Dellinger, in March, 1876 (Ex. E); Gustweit, between 1870 and 1876; Bowen, in September, 1878; Hale, in fall of 1875 (Ex. D); Michael Dellinger, in November, 1877 (Ex. D); Harman K. Drawbaugh, in January, 1875, and helped put up wire for them; J. B. Drawbaugh, prior to Jan. 26, 1875; George W. Drawbaugh identifies all the exhibits as seen by him some time between 1871 and 1878; Musser, in 1876; Smith, in 1872 or 1876 (Ex. E); Updegraff, in May, 1876 (Ex. D); J. H. Smith, in May, 1876 (Ex. D); Decker, in 1874 (Ex. D); Vannasdale, in February, 1875; Evans, in fall of 1875; Mrs. Erb, in fall of 1875; S. E. Evans, in fall of 1875 (Ex. D); M. E. Evans, in fall of 1875 (Ex. D). Some of the witnesses who identify exhibits identify the whole series. Other witnesses besides those named identify one or more of the exhibits as seen by them at times subsequent to the date of Bell's applications for his patent. Some of the witnesses who identify one or more of the instruments exhibited to them by Drawbaugh as the Exhibits F, B, or C, saw or used them in 1875 or 1876. Among these are the following, to whose testimony a reference will be made:—

Mr. Springer testifies that he repeatedly talked and listened with Drawbaugh through the instruments after the 1st of April, 1876, using Exhibits F and B as the instruments. Mr. Musser testifies that he talked through F and B in June, 1874; but the proofs show that this occasion was as late as in the summer of 1876. Mr. Moore, who is produced to show that Drawbaugh applied to him to acquire an interest in the invention, testifies that the talking machine which Drawbaugh produced was Exhibit B. This was in May, 1875. Mr. Bayler testifies that he talked through F and B in 1873, but the proofs show that the occasion was between 1875 and 1877. Mr. Nicholas locates the middle of January, 1875, as the time when he saw Exhibit B in use.

That the talking machines referred to by the witnesses were electric instruments is clearly established. Drawbaugh testifies explicitly that they were always used with a closed circuit and without breaking the current, some of them being battery telephones and some magneto-telephones. He always represented them as actuated by electricity to those to whom he explained or described them, and claimed his invention would supersede the telegraph. His assertions show them to have been electrical instruments. He stated to the witness Shank, "It was the greatest invention ever known. If he had the means to go on with it they could talk, or rather be a time to come as to talk to the old country same as we can talk here;" to Zacharias, that "he could run it out for miles, and parties could talk in at one end and be heard at the other end, the same as persons in a room together;" to Smith, that "parties between Harrisburg and Philadelphia could communicate as if they were speaking together; there would hardly be any limits;" it was an "instrument to convey the voice, to supply the place of the telegraph;" to Smyser, that it would work "from here to California;" to Fry, that one "can talk as far as the wire goes;" to Carl, that "he could hear a man talking from that place to New Cumberland or Harrisburg, and understand distinctly what he said;" to Sherick, that it was "better and handier than the telegraph; that you could just talk through it in place of writing;" to Blasley, that "by attaching two wires you can hear it a way off; the telegraph is nowhere with it;" to Kahney, that "he could talk the same for miles as he could for short distances;" to Shettel, that "if he had a wire from the shop in connection with the telegraph wires at White Hill he could talk to

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Mechanicsburg by having a machine there or an instrument in the office; that it would be better than telegraphing, and that it would be worth a great deal of money;" to Reneker, that "he thought he could make it that he could talk through to Harrisburg; he thought they would take the place of telegraphing;" to Weber, that "it beats all the others of my inventions; he could carry sound, or rather talk, as far as Shiremanstown;" to Hawn, that "he would be able to operate, that a man preaching in New York, that a congregation in Philadelphia would hear the same sermon;" to Kahney, that "he could just as easy speak ten miles as one, or any distance he would choose to;" to Rupp, who was there with Hammacher, that "it was worked by electricity; would take the place of the telegraph, and that he could make it so that he could talk to San Francisco;" to Musser, that "he was going to make a machine to talk from Harrisburg to Philadelphia, and it would be a cheaper and quicker way than telegraphing;" to Smith, that "he believed they could talk for a hundred miles;" to Fetterow, that "I could speak ten, fifteen, or twenty miles, or even to California, if there was a wire extended;" to Wisler, that "he could attach a wire to it and talk for ten miles, as far as he could have a circuit around;" to H. F. Drawbaugh, that "he could talk across the continent;" to Free, that "the talking machine could be used to talk at a long distance, from Philadelphia to California;" to Landis, that "it could be used a thousand miles; it would take the place of the telegraph;" to Lenig, that "he could talk hundreds of miles through that;" to Updegraff, that "instead of using the old mode of telegraphing he could talk directly through the wire; he thought he could talk as far as you could use the ordinary telegraph wire;" to Draper, that "he thought it was or would be one of the greatest inventions of the age, and would take the place of telegraphing;" to A. Evans, that "he could take this machine and talk clear out to Europe across the ocean;" to Eicholz, that "if he could only get some one to help him once he would run it to Harrisburg, and convince them, and then he would run it from Harrisburg to Philadelphia." He stated to the witness Shank that "it works by electricity;" to Smith, that "it was by electricity;" to Nichols, that "the sound was conducted by electricity;" to C. Eberly, that "the instruments were to convey sound by electricity;" to Coudry, that "they were operated by electricity;" to Shoop, that "it operated by a battery;" to Shireman, that "they operated by magnetism;" to Hawn, that "they would be operated on by a battery;" to N. W. Kahney, that "the machine was operated by electricity by a battery;" to Zimmerman, that "it was electricity that would pass it over the wires; that it would carry the sound right along;" to Hale, that "it was driven by a magnet;" to H. K. Drawbaugh, that "the sound could be carried to a distance on a wire by the use of electricity;" to Lenif, that "electricity was used in connection with it;" to Professor Heiges, that "in connection with a talking machine both magnetism and electricity were applied;" to Goodyear, that "his talking machine was also done by electricity over wires;" to Woods, that "it was to be an electric machine used in place of telegraphing;" to Young, that "it was an electric talking machine which he had invented."

Thus Drawbaugh is corroborated by a cloud of witnesses whose testimony tends to substantiate his narrative. Without stopping at this point to consider the credibility and probative force of their testimony, it suffices to state that, although some of the witnesses seem to have been reckless and unscrupulous in their statements, the great body of them are undoubtedly honest witnesses. It is impossible, however, to believe that Drawbaugh can be mistaken in the substance of his testimony, and the conclusion cannot be ignored that either his testimony is true in its essential parts, or his narrative has been manufactured to fit the exigencies of the case. In order to ascertain what effect is to be given to the corroborative proofs it is important to determine whether Drawbaugh is an honest witness or whether he has intentionally falsified collateral facts, and is therefore to be deemed discredited.

If the defence is to be believed, he had been experimenting with his talking machine from 1866, and had successfully transmitted speech as early as 1870, if not before that time. He testifies that he had used Exhibits B and F in transmitting speech for two or three years before he made Exhibit C. According to the theory of the defendants, Exhibit C was made in 1869 or 1870. At that time he had reached a secondary stage in the development of his invention, and certainly as early as in 1872, when Exhibit C had received its latest modifications, the invention had passed out of the period of rudimental forms, embodying principle merely, into a form embodying nice details of construction, and had reached a perfection not reached by Bell in his earlier patent. Drawbaugh was well aware of the merit and of the great pecuniary value of the invention; he had obtained patents for several inventions of minor value, yet from 1870 until July, 1880, he did not apply for a patent for the telephone. It was of the first importance to explain the reason of his inaction, because it seems incredible that the inventor of the telephone should not only omit to patent it as soon as he could, but should also remain silent for years after others were winning the fame and profits of the invention. Only one explanation was possible, and that has been attempted. As stated in the answer and in his testimony, it is that he was unable to do so by reason of his poverty. The answer alleges "that for more than ten years prior to 1880 he was miserably poor and utterly unable to patent his invention or caveat it." He was asked the question: "Do you mean to have it understood from your last answer that there was any other reason for some period prior to 1870, except your poverty, whether greater or less, which prevented you from patenting your invention, or filing a caveat for it?" His answer was: "If I understand that right, there was no other reason that I can think of now." He proceeds to state that Exhibits F and B exhibited the principle perfectly enough to patent. In the elaborate efforts of the defendants to substantiate the theory of Drawbaugh's inability from poverty to patent his invention, much testimony has been produced to show, and which does show, that he was always more or less in debt, often a borrower of small sums of money, was dilatory in paying his debts and used to plead his inability when dunned, and was often sued and judgment and executions were obtained against him. But it is clear from a few plain facts that the theory of extreme poverty is unfounded, and that Drawbaugh is dishonest in putting it forward. In 1867 and 1869, besides what he received for his wages, he received 5,000dols. from the Pump Company for his faucet invention, besides 1,000dols. in the stock of the concern. On the 1st day of April, 1869, he received 1,000dols. from one Gardner for the sale of a half interest in a faucet invention. He invested 2,000dols. of the 5,000dols. in real estate, lost 400dols of it in an apple speculation, and used the 1,000dols. received from Gardner to buy a house and lot for his father. Between 1867 and 1873 he paid 1,200dols. to the Drawbaugh Manufacturing Company for assessments on his stock, besides 870dols. in labour; and in July, 1873, received from that company 425dols. cash in settlement of its affairs. From 1867 to April, 1872, he was the owner of real estate for which he had paid 2,300dols. in the fall of 1867, and upon which he expended in improvements in the spring of 1868 from 300dols. to 400dols., and which was encumbered only by a prior lien for 300dols. In the spring of 1872 he encumbered it for 1,000dols., not as a principal but as a surety. He was in receipt of 110dols. annually, as rent for a part of this property, occupying the rest himself, until he sold it in 1876 and bought another house in the town of Mechanicsville. He was always in receipt of fair wages for his labour. From April 1, 1875, to April 1, 1876, he received nearly 450dols. for wages from the Axle Company, irrespective of his earnings from other sources, and declined steady work at times because he could make more by job work. Thus it appears that, although it was not convenient at times for him to pay his debts, or he was careless or indifferent, he had not only the means of raising money during all this period, but that on many occasions he had means for investment and for speculation. The pretence that he could not raise the fees to caveat or patent his invention is transparently absurd.

He was accustomed to prepare specifications of patents, and was a maker of models, and advertised himself as an inventor, designer, and solicitor of patents. During the time he was experimenting on his talking machine, and before he applied for a patent, he found time and materials for experimenting with and making the Gifford injector for steam engines, the autograph telegraph, the magneto-dial telegraph, the magneto key, the automatic fire-alarm and the electric clock. During this period he was a friend of Mr. Weaver, a patent solicitor, who frequently gave him advice and professional assistance in return for mechanical services rendered by Drawbaugh, and who drew specifications for him for a measuring faucet and for the magnetic clock. If he was not competent himself to make an application for the patent, it cannot be doubted that with the assistance of Weaver he could have made a proper application at a trifling outlay, if any, beyond the fees of the office.

Drawbaugh devoted a good deal of time between 1867 and 1878 to the invention and construction of his electric clock, and the time and money expended by him in experimenting and constructing this clock in its various forms, especially those made in 1877, 1878, was much more than would have enabled him to patent his talking machine. These clocks were built by him with his own tools and out of his own money, and to build them economically he made a gear cutting machine, which must have cost him more than it would to patent his telephone. In April 1878, he received 500dols. from the Electric Clock Company for the privilege of using his clock invention.

In order to fortify the theory of Drawbaugh's inability from poverty to patent his invention, the defendants have attempted by testimony from him and from others to show that he was extremely solicitous to patent it, and tried to induce others to furnish the means. Mr. Springer testifies that "his (Drawbaugh's) whole mind appeared to be on his talking machine; he told me that many a night he didn't sleep just studying how to improve it." After May, 1872, according to the testimony of Jacob Hawn, the talking machine superseded the clock in Drawbaugh's interest. According to Mr. Holsinger, from 1873 to 1876, "he appeared to be crazy on it. I often tried to get information from him on other subjects, and about half minute's talk would turn him right on the talking machine." Henry F. Drawbaugh, his brother, testifies, "Every time I was down there, from the summer of 1872 to 1879 or 1880, he was working at it and talking, and wanted me to go in with him and furnish means." Mr. Bates says he was in Drawbaugh's shop eight or ten times between the summer of 1874 and the fall of 1877, and "his general conversation was about the talking machine; said he would like to get it patented but had not the means, and could make a fortune out of it." Drawbaugh testifies as follows: "Question. A good many witnesses have testified that you were at various times talking of patenting your electric speaking telephone invention; what is your recollection about that, did you intend to patent it or not? Answer. Yes, sir, I intended to patent it. I had spoken to a number of persons to assist me. I would state to them that I would give them an interest in the invention for them to furnish the money to have it patented. Question. Why did you not patent it with your own money? Answer. I did not have any money. Question. At how early a time did you have the intention of patenting it? Answer. I could hardly say how early. I spoke to persons even at an early time. I spoke to Christian Eberly; it may have been prior to 1870 I spoke to Frank Lee; I spoke to them about taking an interest. They were among the earliest. I can't remember all the persons, as I had spoken to a great many." Lee is not a witness, having died in 1872. Christian Eberly locates the time as between 1867 and 1870. He had been a partner with Drawbaugh in a number of inventions and was a capitalist. He was asked: "When Mr. Drawbaugh showed you his talking machine, state whether he proposed to you to go into partnership with him and furnish the money for that also as you had before that time on the other inventions?" He answered: "Not altogether; he intimated that he would take me in. I don't recollect as

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I said anything, or what I said." The witness was often in Drawbaugh's shop subsequently, in 1871, 1872, and 1873, but mentions no other propositions. The only other persons Drawbaugh specifies as having been applied to by him are Capt. Moore, Henry Bayler, and Simon Oyster. Oyster was not called as a witness. Capt. Moore was examined as a witness for the defendants, and his testimony is significant. He was the principal of the Soldiers' Orphan School, an institution in the vicinity of Eberly's Mills, and was the secretary and treasurer of the Axle Company, a concern that in part occupied Drawbaugh's shop in 1875 and 1876. He testifies that in May, 1875, Drawbaugh showed him a talking machine; said he was unable to patent it himself, and desired witness to "go in with him and get a patent." He states that he told Drawbaugh he didn't want to go into any new inventions, but that it would be a fortune to any person bringing it out if it could be put to practical use. He identifies Exhibit B as the machine shown him at that time by Drawbaugh. Although he and Drawbaugh maintained intimate business relations for a year after that time the subject seems never to have been referred to again. Mr. Moore was an intelligent capitalist. It is strange that Drawbaugh should have shown him Exhibit B, the crude instrument of 1867-1869, if the perfect instruments E and D were in existence; and more strange that the subject was never mentioned again between them if they had any faith in the value of the invention. Mr. Bayler, the other witness, carried on lumbering and a saw-mill from 1873 to 1877 in the vicinity of Milltown, and employed Drawbaugh frequently to repair machinery. He testifies that in June, 1873, Drawbaugh showed him the talking machine, and he said to Drawbaugh, "Why, Dan, that is virtually a talking telegraph," and advised him to take out a patent for it, to which Drawbaugh replied: "If I had the means I would; if you'll advance me the means to procure a patent I'll give you a half interest." The witness continues: "Generally on him meeting me he would urge it, urge me to take an interest by furnishing him the means to take out a patent." He also identifies Exhibits F and B as the instruments shown him by Drawbaugh. But his books show that during all the time from April, 1873, to May, 1876, he owed Drawbaugh more than the fees necessary for producing a patent.

The defendants produce other witnesses to prove that from 1870 to 1879 Drawbaugh was showing his telephone, adverting to his property, and trying to induce somebody to assist him. Mr. Herr may be cited as in illustration. He testified that in 1870 or 1871 Drawbaugh wanted money to get a caveat to secure his invention, and told the witness if he would help him or procure any person to assist him he would give him a half interest. Without adverting further to the testimony on this subject it is sufficient to say, in view of the fact that there never was a time from 1867 to 1880 when Drawbaugh did not have the money to caveat and patent his invention or the means of borrowing it, the only legitimate effect of such testimony is to discredit the whole defence by exciting the suspicion that it is bolstered up by exaggerated and unreliable testimony. It will hereafter be shown that, among the men with whom Drawbaugh maintained business and friendly relations during this period, there were many of intelligence and means. Some of them may have distrusted his judgment and regarded him as a visionary. Some of them may have been indifferent or timid. But it is incredible that, when only a trifling sum was required for a half interest in the invention, none of them could be sufficiently impressed with its merit or financial value to investigate it seriously as a speculation or an investment. He induced persons to invest in faucet inventions and in his magnetic clock; and it cannot be true that he could find no one to entertain the talking machine which, according to the common rumour of the neighbourhood, was to supersede the telegraph, and, in the words of one of the witnesses, "make Drawbaugh one of the richest men in Cumberland Valley." It was very natural that a hard-headed old farmer like William Daer, on being told by Drawbaugh that he had a machine by which he could talk across the Atlantic Ocean, should advise him to "try it first in talking across the Yellow Breeches Creek," but it is beyond comprehension or belief that none of the capitalists or speculators about him could be induced to seriously consider it if it was an operative device.

Where a witness falsifies a fact in respect to which he cannot be presumed liable to mistake, Courts are bound, upon principles of law, morality, and justice, to apply the maxim *Falsus in uno, falsus in omnibus.* The Trinidad, 7 Wheat., 283. Drawbaugh could not be mistaken in asserting that it was his poverty which prevented him from caveating or patenting his invention. He was not led to the assertion inadvertently. Those with whom he is associated in the defence understood fully, and so did he, that the fact that a professional inventor and patentee did not go to the Patent Office to secure an invention like the telephone for ten years after it had been completed and demonstrated was almost conclusive against the theory that he made the invention, and that unless this presumption could be parried no Court would credit his story. The theory of constraining poverty was therefore formulated in the answer, elaborately fortified by witnesses, and testified to by Drawbaugh. It is overthrown by a few plain, indisputable facts, and Drawbaugh's veracity falls with it.

The defence must rest upon the testimony of the witnesses who corroborate Drawbaugh. The case made by these witnesses is sufficiently formidable to overcome the legal presumption of the validity of the complainant's patents. It is met by the complainant with rebutting evidence, direct and circumstantial, showing the intrinsic improbability of the theory that Drawbaugh was the inventor of the telephone, and showing his conduct or declarations inconsistent with any hypothesis that he was more than an unsuccessful experimenter with the invention. Many witnesses have also been produced by the complainant to attack the credibility and reliability of the testimony of the defendants' witnesses. Of necessity the testimony of most of the defendants' witnesses can only be attacked by showing that witnesses are mistaken as to the time when they saw Drawbaugh's talking machine, or as to what they really saw on the occasions they refer to. The way in which the testimony of Uriah P. Nichols is met will illustrate the general tenor of such testimony. Mr. Nichols was one of the most intelligent and trustworthy of the defendants' witnesses, a farmer and machinist, who testified that on the 18th day of January, 1875, he visited Drawbaugh's shop on business, saw two instruments which he identified as Exhibits B and A, and described their mode of operations as stated to him by Drawbaugh at the time; he says he listened at one instrument while a boy spoke into another two hundred feet away, connected by wires, and heard the boy say: "Is it you, father, speaking?" The complainant produces nine witnesses to show that the occasion could not have been prior to February, 1878. The witness fixes the date by a purchase of lime made by him on the visit, and states that he went to Drawbaugh to see an electric clock of which he recently read a description in a newspaper, and soon after the visit told Mr. Maish and others about the telephone he had seen at Drawbaugh's. The complainant proves that the newspaper article was not published until February, 1878; that when the witness told Mr. Maish of the telephone at Drawbaugh's the latter, who was then a member of Congress, remembered the occasion, knew all about Bell's telephone at the time, and had used it in Washington. Mr. Maish states that as Drawbaugh was one of his constituents he would have been deeply impressed by the conversation if he had understood Drawbaugh claimed to be the inventor. Without attempting to particularise the rest of the testimony for the complainant upon the issue, it suffices to say that several other witnesses were introduced to show that the lime was purchased by Nichols in 1878. Much testimony is given by complainant upon collateral issues of a similar character. One of these issues relates to the time when Thomas Draper ordered a hydraulic ram of Drawbaugh. Mr. Draper was an important witness for the defendants. He testified that he went with Mr. Kissinger, a tenant of his, to Drawbaugh's shop in May or the early summer of 1874, for the purpose of ordering of Drawbaugh a hydraulic ram to be used upon the farm Kissinger had leased of him in April, and that he was never at Drawbaugh's on any other occasion. He identified Exhibit C positively, and Exhibit I less positively as the instruments used, and through which he listened while Drawbaugh talked. The complainant proved that the hydraulic ram was not put to use until the fall of 1878, and undertook to locate the date of Draper's visit approximately by that fact. Seventy-five witnesses were introduced by the respective parties upon the collateral issues. These illustrations show how hopeless a task it would be to review the testimony satisfactorily or analyse it minutely. Five hundred witnesses have been examined by the parties upon the main question and the collateral issues, and their testimony is in a printed record of over 6,000 pages. If it were practicable to do so it would not be profitable, because a microscopic view of the controversy would be inadequate and misleading. In cases where such a chaos of oral testimony exists, it is usually found that the judgment is convinced by a few leading facts and indicia outlined so clearly that they cannot be obscured by prevarication or the aberrations of memory. Such facts and indicia are found here, and they are so persuasive and cogent that the testimony of a myriad of witnesses cannot prevail against them.

(TO BE CONTINUED.)

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. Feb. 4.		Business Done Week Ending Feb. 4. Highest.	Lowest.
Anglo-American	31,	32	32	30⅞
Do. Preferred	55,	56	56½	54½
Do. Deferred	7⅞,	8¼	7 15-16	7⅞
Brazilian Submarine	11,	11½	11½	11
Cuba	10¾,	11¼	—	—
Do. Preference	17½,	18½	—	—
Direct Spanish	2,	2½	—	—
Do. Preference	11,	12	—	—
Direct United States Cable	9½,	9⅞	9⅞	9⅞
Eastern Telegraph	11⅝,	11¾	11¾	11⅝
Do. 6 per Cent. Preference	13⅜,	14½	14½	14
Do. 5 per Cent. Debentures, 1899	103,	106	—	—
Eastern Extension	12⅜,	12⅝	12⅝	12⅜
German Union	9½,	10	—	—
Globe Telegraph and Trust	6¾,	7⅛	7 1-16	6¾
Do. Preference	12⅜,	12¾	12¾	12 9-16
Great Northern	14¾,	15½	15½	14 15-16
Indo-European	32,	33	33	32⅜
Reuter's	7½,	8	—	—
Submarine	185,	190	187	182
West India and Panama	⅝,	¾	—	—
Do. 1st Preference	7½,	7¾	7½	—
Western Brazilian	6¾,	6¾	6¾	—
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	⅜	—
Oriental	½,	⅝	⅝	—
United Telephone	11,	11½	11½	11 3-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	1⅝	1⅜
Do. (fully paid)	3,	3½	—	—
Hammond Light (£3 15s. paid)	⅝,	¾	15-16	11-16
Swan	½,	⅝	5-16	—
Maxim-Weston	¼,	⅜	—	—

MISCELLANEOUS.

Telegraph Construction	34¼,	35½	35½	34⅜
India Rubber, Gutta Percha, and Telegraph Works	21½,	22½	22⅞	22⅛

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NOTES.

THE POSTMASTER-GENERAL.—Mr. Shaw-Lefevre, the new Postmaster-General, has been elevated to a seat in the Cabinet.

LUNDY ISLAND CABLE.—This cable has been interrupted for over three weeks, but at present the fault has not been detected.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 6th February amounted to £3,542.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 6th February were £2,823, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

CURRENTS AND CURRANTS.—*Il Giorno* says that a noted pastrycook of Milan obtains, with an apparatus of his own invention and "a discrete electric current," results which satisfy not only the taste, but also the eyes of his numerous customers.

SS. "ELECTRA."—In describing the system of ventilation applied to the ss. "Electra," p. 261 of last issue, the holes cut through decks in all cabins should read 6in. by 4in., being same size as those in ss. "Volta," and ss. "Magneta," instead of 16in. by 4in.

THE WAR OFFICE AND THE EASTERN TELEGRAPH COMPANY.—A special telegraph wire has been laid on to the War Office from the Eastern Telegraph Company's office in the City, so that not a moment's delay will take place in the receipt of telegrams from the front.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 31st Jan. are £2,684, as compared with £2,865 in the corresponding period of 1884. The October receipts, estimated at £4,147, realised £4,231.

MAXIM-WESTON ELECTRIC COMPANY.—A notice has been given that this company, after making up the deficit in profit and loss account of £2,544 14s. 7d. for last year, has just declared a dividend at the rate of 5 per cent. for the last four months, carrying forward £764 5s. 3½d.

ELECTRICAL LECTURES.—Professor Ryan, of Nottingham University, delivered the second of a course of lectures on "Electricity" in the Town Hall, Ilkeston, on Thursday evening, Feb. 5. These lectures are in connection with the University Extension scheme, and are well attended.

TELEGRAMS FOR THE WEST INDIES.—The cables between St. Kitts and Antigua, and between St. Vincent and Grenada are interrupted; there is, therefore, at present no telegraphic communication with the islands of Antigua, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, and Barbadoes.

GREAT NORTHERN TELEGRAPH COMPANY.—This company notifies that a telegraph station has been opened at Pakhoi in China. The traffic receipts of this company for January, 1885, amounted to £20,800, against £19,360 and £18,400 respectively, in the corresponding months of 1884 and 1883.

TEMPORARY LIGHTING AT BARCELONA.—The most important electric light installation in Spain, though of a temporary nature and put down in a few days, is said to have been that of fifty-two Gramme lamps between the Plaza de Cataluna and the Rambla de Santa Monica, Barcelona, on the occasion of the recent festivities.

ELECTRICAL TRAMCAR AT WANDSWORTH.—The General Purposes Committee of the Wandsworth Board of Works has arranged with Messrs. Siemens Brothers for an electrical engineer to attend and advise the committee during its inspection of the electric car proposed to be used on the tramway lines in Battersea.

THE BELL PATENT IN CANADA.—On 24th January the Canadian Minister of Agriculture and Commissioner of Patents gave his decision, *in re* the Toronto Telephone Company *v.* the Bell Telephone Company of Canada, declaring null and void the Patent No. 7,789, granted on 22nd August, 1877, to Alexander Graham Bell.

ANGLO-AMERICAN TELEGRAPH COMPANY.—We are informed that, with reference to the resolution proposed by Mr. Abbott, Mr. Cyrus Field telegraphed to the company on the 7th Feb., 1885, as follows:—"I am not now and never have been interested to the extent of a single pound in any rival scheme to the Anglo-American Telegraph Company."

COST OF TRANSATLANTIC TELEGRAPHY.—The sums paid for transatlantic telegraphy during 1884 amounted in the aggregate to £888,000, while for the preceding year the amount was £939,000, at the same rate, the reduction being due to depressed trade. Although indications are not wanting of reviving trade, the tariff is somewhat lower.

ELECTRICAL EXHIBITION AT BRUSSELS.—It is intended to hold at Brussels this year an exhibition of electric apparatus chiefly for lighting, and also gas appliances. The difficulty appears to find a suitable building; but the organising committee hope to have the Palais du Midi (intended for the industrial school) placed at its disposal, owing to an arrangement between the State and the Municipality.

ELECTRICAL WORKING OF LEVEL CROSSING GATES.—A scheme for opening and shutting level crossing gates by electricity is being tested in France. A catch, governed by an electro-magnet, secures the gates; and the train, on approaching, closes the electric circuit and releases the catch, when the gates open. The train having passed, the circuit is broken, the gates are shut, and they are secured again by the catch.

ELECTRIC LIGHT IN ITALY.—At the town of Terni, in North Italy, celebrated for its waterfall, the theatre has been electrically illuminated by Calandri, Viglino, and Bizzoni, who are about to lay down plant for lighting the Terni Club and some of the principal shops, distant a kilometre (0·62 mile) from the generating machine. A description of the electric lighting operations at Terni will be found in our issue of July 26, 1884.

INFLUENCE OF PETROLEUM CANS ON THE COMPASS.—It is asserted that refined petroleum in tin cases exerts an influence on the compasses of a vessel equal to the same quantity of iron or steel. The masters of the German ship "J. Weisselholm" and the schooner "Maggie Dalling" have sent in reports confirming the above statement; and in the latter case the captain asserts that his vessel went ashore through an error caused by cased petroleum.

THE TELEPHONE IN PARIS.—In accordance with an arrangement between the French Ministry of Telegraphs and the Société Générale des Telephones, the tariff for conversation between two different towns is fixed at 1f. (10d.) for distances under 100 kilometres; and this is to be reduced one half when two towns in telephonic communication shall have been classed by Ministerial decision as forming part of the same telephonic group.

OVERHEAD WIRES AT WANDSWORTH.—The General Purposes Committee of the Wandsworth Board of Works, having

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considered the report of the surveyor for Streatham as to telegraph wires having been erected by the London, Brighton, and South Coast Railway Company over Streatham High Road, at Streatham Station, recommended that the company be called upon to remove the wires in question forthwith; and this recommendation was adopted.

UNION ELECTRIC LIGHT AND POWER COMPANY.—The affairs of the Union Electric Light and Power Company being now fully wound up, the liquidators have given notice that a general meeting of the company will be held at the late registered office of the company, St. Stephen's-chambers, Telegraph-street, E.C., on Monday, 23rd inst., at 2 p.m., when an account will be submitted, showing how the winding-up has been conducted and the company's property disposed of.

ELECTRIC LIGHTING AT THE SOCIETY OF ARTS.—We mentioned some time back that accumulators were being tried at the above institution in connection with the existing electric lighting. These were put in as regulators; but on more than one occasion they have supplied the current for all the lamps in the lecture room throughout the evening. The result has been considered by the council so satisfactory that the Storage Company has received an order to fix permanently a set of cells of their latest type.

ELECTRIC LIGHT AT BOSTON.—It appears from the annual report of the Superintendent of Lamps for the city of Boston (U.S.A.) for the past year, dealing with the three systems of illumination—gas, oil, and electricity—employed, that there were 401 electric lamps in use last year, costing the city 65 cents per lamp per night, or 237 dols. 25 cents. per annum. The total cost of these lamps (the greater portion of which are Brush) was 95,137 dols. 25 cents.

LIGHTING FOR BROOKLYN.—The following proposals for lighting the streets of Brooklyn, U.S.A., have been submitted:—From the Municipal Electric Light Company, lights for various streets, 255·50dols. per annum for each standard arc electric light furnished; from the Brooklyn Electric Light Company, for furnishing electric lights in various streets of the Western District, 255·50dols. per lamp per annum, lamps to be erected within the territory covered by the company's wires.

TELEPHONE AT THE CLUBS.—The members of the Sheffield Club have had before them a proposition for introducing the telephone; but only four out of about fifty members voted for the motion, which was accordingly lost. The directors of the Sheffield Athenæum have had a memorial, signed by over sixty members, presented to them, asking for the telephone to be extended to that institution, and a sub-committee having reported favourably, the telephone may be tried for a year to ascertain how far it is appreciated by the members.

PRESENTATION.—Mr. John D. Miller, local manager of the National Telephone Company, has been presented by the subscribers to the Aberdeen Exchange with an illuminated address in token of their appreciation of the services rendered by him as manager to the company at Aberdeen. Reference is made in the address to Mr. Miller's careful management, and the ability, tact, and courtesy which he manifested in commencing his duties under considerable difficulties, and in carrying them to a successful issue. Notice is also taken of the degree of S.T.E. and E. obtained by Mr. Miller in recognition of his engineering skill.

ELECTRO DEPOSIT OF NICKEL ON ZINC.—In coating zinc with nickel, by means of a galvanic current, the zinc must first be cleaned by diluted hydrochloric acid and thoroughly washed. It is then hung in the nickel bath for a short time, taken out, rinsed, and thoroughly scraped, so as to remove all the metal that does not adhere firmly. This operation is repeated till the zinc is covered with a thin film of nickel, which can afterwards be made as thick as required. The suitable current strength is easily found; and when the zinc is once thoroughly covered, the current may be increased without any risk of the nickel peeling off.

PRESERVING TELEGRAPH POSTS.—A correspondent to the *Timber Trades Journal* says that, to prevent the decay of posts at the level of the ground they should be protected, say 6in. above and 6in. below this point, with sheet zinc closely nailed round; and another good plan is to shoe the posts with wood, allowing the shoe to come 6in. or so above the ground. This offers a larger volume of wood to the action of disintegration at the ground level, and gives the post an extended lease of durability. Though the ordinary charring and tarring are no mean preservatives, it is a popular error to apply these remedies to other points than those of the ground level.

THERMO ELECTRICITY.—Professor Riatti has constructed a thermo-electric cell, based upon the principle that the production of electricity is due to the difference of the temperature of two parts of a single fluid. The cell consists of a receptacle of wood or porcelain, traversed by two tubes of copper, with wires at a certain distance between them. By the principal tube a jet of steam is passed, and by the other cold water. The outer jar contains a solution of sulphate of copper. When the circuit is made, the copper of one of the tubes is dissolved, and is deposited in the other. This cell is said to be constant, and not liable to polarisation.

THE TELEPHONE BETWEEN PERTH AND DUNDEE.—A new telephone wire between Dundee and Perth was inaugurated at the central office of the National Telephone Company on the 9th inst. The wire is about 22 miles long, and, with the exception of the wires between Glasgow and Edinburgh and Glasgow and Greenock, is the longest distance to which a National Company's wire extends. The wire to Perth is the first instalment of a projected wire to Glasgow, and probably to Edinburgh. A trunk wire to Arbroath is almost completed, and from thence another is to be carried to Brechin and Montrose, and then on to Aberdeen.

ELECTROLYTICAL SEPARATION OF METALS.—Mr. B. Moebius, of Chihuahua, Mexico, has invented apparatus for refining silver and separating it from gold, platinum, copper, lead, and other metals by means of the electric current. The elements forming the anodes and cathodes of the battery have brushes for preventing the accumulation of metals or peroxides, and oxygen or hydrogen bubbles. The exciting liquid, contained in a water-tight tank, consists of a nitrate of silver solution, acidulated with nitric acid to which nitrate of copper is added. The liquid is heated for diminishing the internal resistance and favouring decomposition of the anode.

ACCIDENT TO ONE OF CROMPTON'S MEN.—The annual dinner of the *employés* at the Chelmsford Electric Light Works, which was held on Saturday evening at the Corn Exchange, Chelmsford, was followed by a shocking accident. About an hour after the company had dispersed the hall-keeper went into the cellar for the purpose of turning off the gas, when he found a man named Edwards, who was employed at the Electric Works, lying at the bottom of the steps quite dead, his skull having been fractured. The door at the head of the steps being open, it is supposed that the unfortunate man stumbled against it and fell head foremost to the bottom.

NOVEL LIGHTNING CONDUCTOR.—The apex of the Washington monument, 500ft. high, and now approaching completion, is protected against the lightning shock by a large conical

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block of aluminum, to the bottom part of which will be attached a large copper bolt or cord, divided into four parts, one led to each of the four heavy columns supporting the elevator. These in turn will be connected with the well near the base of the monument, thus making a complete and ample connection between its summit and the earth. A similar connection between the temporary top of the column and the earth has always been maintained, thus protecting the workmen as well as the structure itself from the effects of any electrical disturbances.

THE TELEGRAPH BATTALION.—Instructions were received at Aldershot on Monday to hold the air-line section of the Telegraph Battalion Royal Engineers in immediate readiness to embark for Suakim. The section, which numbers about forty non-commissioned officers and men, will be under the command of Lieut. Lindsay. An opinion prevails at the camp that, unless the reserves of this particular arm are called out, very few men will be available, as nearly the whole of this battalion is already in Egypt and at the Cape. Later information states that the reserves to be called out will include a detachment of the 24thMiddlesex Volunteer Telegraph Corps. The air line section of the Telegraph Troop of the Royal Engineers will consist of 40 men, 36 horses, and four telegraph waggons. The wire will extend 50 miles.

SHIP LIGHTING.—The new mail steamer, "Trinidad," lying in Hendon Dock, on the Wear, has been fitted by the Edison-Swan United Electrical Company with 150 20-candle incandescent lamps, distributed throughout the vessel. The globes in the saloon are of frosted glass, and each lamp has a switch for turning the light on or off. There are two large deck or cargo lights, intended to be used while the vessel is loading or discharging cargo at night. These two lamps, each equal in power to 400 candles, are composed of eight 50-candle lights each. The current is supplied by an Edison-Hopkinson dynamo, coupled with and worked by a small double engine, supplied by Tangye Brothers, Birmingham. The "Trinidad" is the third mail steamer which has been thus fitted with the electric light in the Wear during the last few months, and also the second steamer fitted by the Edison-Swan Company, the other being the "Funchal."

QUEENSLAND.—We have received a neat and elegant New Year's card from the officers of the Post and Telegraph Department, Queensland, which, besides pleasure, gives information. The telegraph statistics show that in 1860 the revenue was £938; and in 1883, £70,583. The expenditure in the same years was respectively £1,652 and £76,369, while the officers numbered 201 in 1883, against 7 in 1861. The number of messages transmitted in 1861 was 6,189, having a cash value of £938, and value O.H.M.S. of £122. The corresponding figures for 1883 are 1,018,350 messages, cash £68,724, value O.H.M.S. £15,852. In 1860 there were 160 miles of line with 161 miles of wire, which had extended in 1883 to 6,654 miles of line and 10,618 miles of wire. Telephony, unknown in all 1860, established in 1880, is described as having furnished four exchanges and 352 subscribers in 1883. The population of the colony in 1881 was 226,968; and we think the above statistics show the enterprise of the colonists.

CONSTANT ELECTRICAL GAS LIGHTER.—A form of portable electrical gas lighter, in which the spark is produced by the conversion of the mechanical force exerted by the hand upon a button, has been devised by Herr Ullman, who calls it an "everlasting" gas lighter. The external appearance, as described by *La Nature*, resembles that of the battery lighters already in use, the working parts being enclosed within a vulcanite handle, and the spark emanating from metallic points at the end of a suitable rod. The handle contains an inner concentric tube which is caused, by suitable gearing, to rotate rapidly when the button is firmly pressed; and by this rotation a small statical electric machine is constituted, which in due course charges a small fixed induction coil, whereby the spark is caused to appear at the interrupted portion of the circuit. The apparatus therefore works upon the principle of Sir W. Thomson's "replenisher." The operation is much facilitated by the fact that the electrical portion is hermetically enclosed in a suitable case, the enclosure being also kept dry by a small quantity of absorbent material.

HOUSE TO HOUSE DISTRIBUTION OF CURRENT.—A new method, devised by Sgnor Meardi, of distributing high-tension continuous current to private houses is founded on the following principles:—1. Distribution in series of the leads to the apparatus in which the current is utilised, whether lamps, motors, accumulators, baths for electro-deposit, &c. 2. Subdivision of the current intensity among the line conductors in more ratios of various measure; and, consequently, conductors composed of so many elements, each of small section, limited, various and constant capacity, completely insulated and separated from one another. 3. Differential system of counter-tensions, and variable auxiliary resistances, with automatic regulators, capable of being worked by hand in the event of an audible signal being given by a tension indicator attached. 4. Utilisation of the series at will, with slow and progressive graduation of the resistance, when the series is put in and out of circuit, and in measure as the ammeters and audible signals in the laboratory or place of production give warning in sufficient time of the need to modify the tension in the special element of the conductor, so that the intensity always remain constant.

ELECTRIC LIGHT IN THE BATH.—The Turkish bath, lately opened in Savoy-street, Strand, W.C., is electrically lighted throughout by fifty-seven 10 and 20 candle Woodhouse and Rawson incandescent lamps, in fittings by Tayler Smith. The light of each separate lamp may be switched on and off at pleasure; and most of the brackets may be taken down and put up elsewhere, contact being made with metal shields permanently fixed in the walls. Some of the lamps are enclosed in frosted, and others in crystallised globes, while those in the hot rooms form the centre of yellow lilies pendant from the ceiling. The current is supplied by a 60-light Elwell-Parker dynamo, with an 8in. armature, driven at about 1,200 revolutions a minute by a 4-horse Clark horizontal gas engine. The dynamo is sufficient to generate all the current required; but there are also twenty-six 1-horse Elwell-Parker accumulators, each giving out 2·15 volts, which are charged in the morning, so as to afford a reserve in the event of a break-down. The current is sent through the accumulators, which thus act as regulators, securing a remarkably steady light. J. Wells is the electrician in charge.

ELECTRICAL FIRE ALARM.—The fire alarm, devised by M. E. Raikem, which has been favourably reported upon by the Belgian Commission des Procédés Nouveaux, and by the Director-Général des Postes et Télégraphes in the name of the Belgian Minister of Public Works, depends on the principle of air expanding when heated. A chamber made of brass has a porous bottom for permitting the air therein to slowly acquire the same density as that outside. A glass tube, bent to the form of the letter U and containing mercury, is put in communication with the air chamber, and contains a

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platinum wire reaching to the bottom and connected with one of the poles of a battery. A rod, terminating in a platinum wire, the end of which is normally a short distance from the mercury, is inserted in the open arm of the tube and connected with a bell. The mercury remains at the same level in both arms of the tube so long as the temperature remains unchanged, or the increase is so slow that the porosity of the bottom permits the air in the chamber to acquire the temperature of the outer air; but, when the heat is suddenly increased, the air in the chamber expands, depresses the mercury in one arm of the tube, causes it to rise in the other, and, by making electrical contact, rings the bell.

GAMBLING AND BETTING IN THE POST OFFICE.—The Postmaster-General has just issued an official instruction upon gambling and betting, in which he says:—"A case having recently occurred in which betting on horses and playing with cards for stakes far beyond what the players could afford to lose was proved to have taken place, not only on the official premises, but in some instances during the official hours, the Postmaster-General has felt constrained to direct that the superior officer who had taken part in and encouraged these malpractices should be dismissed, and that of six subordinates one should be required to resign and five be reduced in their class, the reduction ranging from four to forty-four steps. A postman also who acted as housekeeper has been deprived of the housekeepership, as well as his good conduct stripe. The Postmaster-General deems it his duty to make these punishments known by way of warning, as in the case of Post Office servants he regards gambling in any form as a most serious offence, and one which it is incumbent on him to put down in an exemplary manner." The Postmaster-General also re-issues a notice concerning betting which appeared in the Post Office Circular of the 26th of August, 1878, as follows:—"Any servant of the Department who shall hereafter be concerned in betting will render himself liable to dismissal."

AN EARLY PIPE-LIGHTER.—It is interesting to compare the following description of a contrivance for producing fire for lighting candles, pipes, &c., with the handy little apparatus provided at the present day by Trouvé and others for the same purposes. The description is from a patent taken out by Mr. Richard Laventz, of Hammersmith, in February, 1807. The apparatus was so contrived that on raising a button an electric spark was produced, which ignited a stream of hydrogen. The gas was produced from a mixture of zinc and muriatic acid in one vessel, ascending by a pipe into another vessel previously filled with water, and forcing the water thence into another and higher vessel which, in proportion as the water rose, pressed by its statical weight, so that when the cock of a pipe was opened allowing it to pass outwards in a small jet with considerable velocity. The electric spark was produced by an electrophone previously excited, which was so connected with the cock above mentioned that the same motion which turned the latter raised the resinous plate of the former from its metallic plate. The spark thus caused passed from one metal knob to another across the hydrogen as it issued, and inflamed it. The knobs were joined to the electrophone by wires. Lastly, a candle was so fixed that the jet of hydrogen must strike its wick. The whole apparatus was included in one portable box of tin or other material. This was before primary batteries and platinum wire were as common as they are now. The metal platinum had, indeed, only been discovered some 60 or 70 years before. The electrophorus was not so old as that, and the primary battery quite in its infancy.

ELECTRIC FISH.—In a magazine published in 1807 it is stated that "Adanson first discovered that the benumbing faculty of certain fishes depends upon electricity. He made his experiments upon the *silurus tremulus*. It is also affirmed that he was the author of the letter on the electricity of the tourmalin, which bears the name of the Duke of Noya Caraffa." This letter was written in 1758; and Adanson is said to have assured the writer of his biography that he was really the author, though it was published in the name of the duke, a Neapolitan nobleman. It was addressed to M. Buffon. Adanson appears to have been a genius of no common order, and made himself famous by his researches in natural history. Born in 1727, at Aix, in Provence, we are told that so early "as the age of five he began to make observations on the smallest plants, such as mosses, which he cultivated in the window, and upon the minutest insects." In 1748 he went to Senegal, where he remained for several years ardently pursuing his favourite study. In 1750 he was elected corresponding member of the French Academy of Science, and in 1759 a member of that body. Our own Royal Society elected him an associate in 1760. He had many tempting offers of lucrative professorships, but he declined all, preferring to live in positive penury, in order to confine his whole attention to botany and natural history. He died on the 3rd August, 1806, in his eightieth year. His lodging at this period was "a ground floor, without cellars, in one of the lowest streets in Paris." He appears to have been descended from a Scotch family which had followed the fortunes of James II.; and his biographer hazards the guess that his proper name was Adamson. An account of his travels and discoveries in Senegal was published in 1757, and afterwards translated into English. Although we are not told so in the memoir from which we have taken the above facts, it is more than probable that this work contained some account of his discovery of the electrical properties of certain fish.

TELEPHONIC CONNECTION OF COASTGUARD STATIONS.—On 9th inst. the Docks and Pilotage Committee of the Aberdeen Harbour Board had before it a letter from the assistant secretary of the Board of Trade, dated 18th October last, with reference to the Board's contribution towards the expense of maintaining telephonic connection between Aberdeen and the coastguard stations at Cove and Donmouth, reminding the Commissioners that the contributions which the Board of Trade guaranteed had now been paid; that whether they would make any further contributions would depend upon circumstances, and have to be considered when the proper time arrives; and requesting that the Department might be furnished with a report showing to what extent the telephone had been of service in connection with vessels in distress. The committee resolved to recommend that a reply should be returned to the Board of Trade to the effect that the telephone has been of great service, and expressing the Commissioners' hope that the Board of Trade will continue the contribution. The committee at the same time instructed the convener, the shoremaster, and the captain pilot, to prepare a report for transmission to the Board of Trade, showing to what extent the telephone has proved of service in connection with vessels in distress. The clerk read a report from the captain pilot to the effect that on several occasions the telephone had been found of great service in notifying the fact that vessels in distress were being driven towards Aberdeen. By receiving notice through the telephone regarding ships in danger, tugs were got ready, and assistance rendered, which resulted in the saving of life and property. Shoremaster Mearns moved the approval of the minute and that the report be sent to the

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Board of Trade. The motion was agreed to; but Baillie Paterson gave notice of a motion in accordance with his remarks, that the telephone being used for commercial purposes as well as for inquiries as to ships in danger or distress, those who used the wire should pay for the privilege, while probably the stamps that had been recently issued by the Telephone Company might be called into requisition.

Electricity in Cotton Mills.—The *Textile Record*, in an article on this subject, says that one of the most formidable foes to be contended with in cotton mills is electricity, which is generated with fearful rapidity, in dry, frosty weather, in all parts of the mill, by the friction of machinery and belting. The writer has frequently, on windy days, removed the conducting wires from the counter and frame driving belts and held "slivers of roving," 42in. long and weighing about 3 grains, opposite a 2in. belt, in which there was sufficient electricity to hold the sliver firmly in a horizontal position. On admitting the sun's rays near the belt, he saw streams of fibre flying in the air and loading the belts with cotton. To ascertain the injury done to the yarn, he selected a place where the electrical force had been subdued by good insulated copper wire conductors, and then tested yarn from ten spindles on the end of a spinning frame nearest the driving belt. Without quoting the experimenter's figures, it is sufficient to say that he found 59 to 65 per cent. of moisture in the air, with a depreciation of nearly 3 per cent. in the quality of the yarn due to the action of electricity; and when there was but 53 per cent. of moisture in the air, and the electricity therefore much more powerful, he found over 4 per cent. difference in quality. By mounting a good magnifying glass over the rollers at the end of the spinning frame, near the belts, the fibres were seen distinctly. On throwing rays of sunlight between the rollers with a good hand mirror, not only were the fibres seen drawn out at right angles from the surface of the sliver as it passed from the bobbin to the rollers; but the fibres between the rollers were seen constantly swinging off at every conceivable angle, giving the thread of warp yarn a rough woolly surface. He insists on the importance of placing all drawing, roving, and warp spinning machinery in the most favourable positions, away from the influences of electricity, the conditions of which are constantly varying, and of providing insulated wires to convey the currents to the ground, care being taken to have an unbroken connection of metal, so that the current shall not be severed.

General Gordon at Aden.—Now that, as a nation, we are mourning the probable death of a simple-hearted soldier, and of one of the greatest of the world's modern heroes, we feel a melancholy satisfaction at being able to contribute our mite to the fund of information respecting him. It has been our good fortune to have met General Gordon, at intervals of years, in several different parts of the world; and it will be fresh in the minds of at all events a few of our readers that he, on the occasion of his proposed voyage to India with Lord Ripon in 1881, honoured the station of the Eastern Telegraph Company, at Aden, by a visit. The eccentricity which invariably marked his character led him to decline the social attentions which the resident and other important executive officials would have thrust upon him; and it is in keeping with his well-known kindness of heart that he should have accorded those favours to the humble which the great sought after in vain. He came to see us one unusually hot morning, toiling up the ninety-two steps from Aden's only road to the summit of Râs Baradli without a murmur, and, walking quietly to the shadow of the office, sat down on a stone and, removing his hat, entered into conversation with one of the junior local clerks, in whose account of Aden he seemed to be vastly interested. One after another we went out and had a peep at "Chinese" Gordon, whom imagination had invested with manifold terrors, but instead of the dreaded fire-eater, we were astonished to find an amiable and unassuming gentleman, who received us not only with kindness but almost with diffidence. After he had rested, and accepted a glass of water at our hands, we had the pleasure of conducting him through the offices and the testing room, where he seemed desirous of remaining until he had mastered every detail of electrical engineering. Shortly afterwards, he took his leave of us with reiterated thanks, and went to the Artillery mess to lunch. It was proposed to invite him to dinner, and had we done so I think he would have come, but somehow or another the project fell through. General Gordon was to those beneath him an essentially charming man. He imparted confidence to the most diffident, and by a series of judicious questions left one, pumped, it is true, but glowing with satisfaction at having contained so much information.

Report of the Kew Committee.—We glean from the report of the Kew Committee for the year ending 31st October, 1884, that the values of the ordinates of the different photographic curves determined in January were :—

Declination : 1 inch = 0° 22′·04. 1 mm. = 0° 0′·87.
Bifilar, January 4, 1884, for 1 inch $\delta H = 0{\cdot}0276$ foot grain unit.
„ 1 mm. „ $= 0{\cdot}0005$ mm. mgr. unit.
Balance, January 4, 1884, „ 1 inch $\delta V = 0{\cdot}0251$ foot grain unit.
„ 1 mm. „ $= 0{\cdot}0005$ mm. mgr. unit.

The distance between the dots of light upon the cylinders of both the bifilar and vertical force magnetometers having become too small for satisfactory registration, it was found necessary to readjust each instrument, after which the scale values were again determined on January 11th, with the following results :—

Bifilar for 1 inch $\delta H = 0{\cdot}0267$ foot grain unit.
„ 1 mm. „ $= 0{\cdot}0005$ mm. mgr. unit.
Balance „ 1 inch $\delta V = 0{\cdot}0296$ foot grain unit.
„ 1 mm. „ $= 0{\cdot}0005$ mm. mgr. unit.

The difficulty experienced in adapting ordinary unprotected gas burners to the bifilar and balance magnetometers, owing to the extremely sensitive nature of the gelatino-bromide paper, has now been overcome by the use of a small screen of blue glass interposed between the flame and mirror. This diminishes the intensity of the light, so that the traces are now well defined instead of being blurred. Professors Rücker and Thorpe visited the Observatory on July 17, 18, and 19, for the purpose of taking a series of absolute magnetic observations preparatory to surveying the western coast of Scotland, as a preliminary operation towards the proposed repetition of the survey of Great Britain and Ireland. The following clocks are kept carefully rated as time-keepers of the Observatory :—French; Shelton K. O.; Shelton No. 35; and Dent 2011. By the courtesy of Mr. Preece, Superintendent of Telegraphs, the Richmond Chief Post Office was placed in direct communication with the Royal Observatory, Greenwich, on January 22, and enabled to receive the time signal at 10 a.m., when a period of cloudy weather had rendered the true time a little uncertain. Among the experimental work, the sub-committee appointed last year as to the magnetic survey of Great Britain and Ireland has now under consideration the details necessary for the early prosecution of the survey; and during the past summer Professors Rücker and Thorpe made preliminary observations at a number of stations along the West Coast of Scotland, their base observations being made at the Observatory as above stated.

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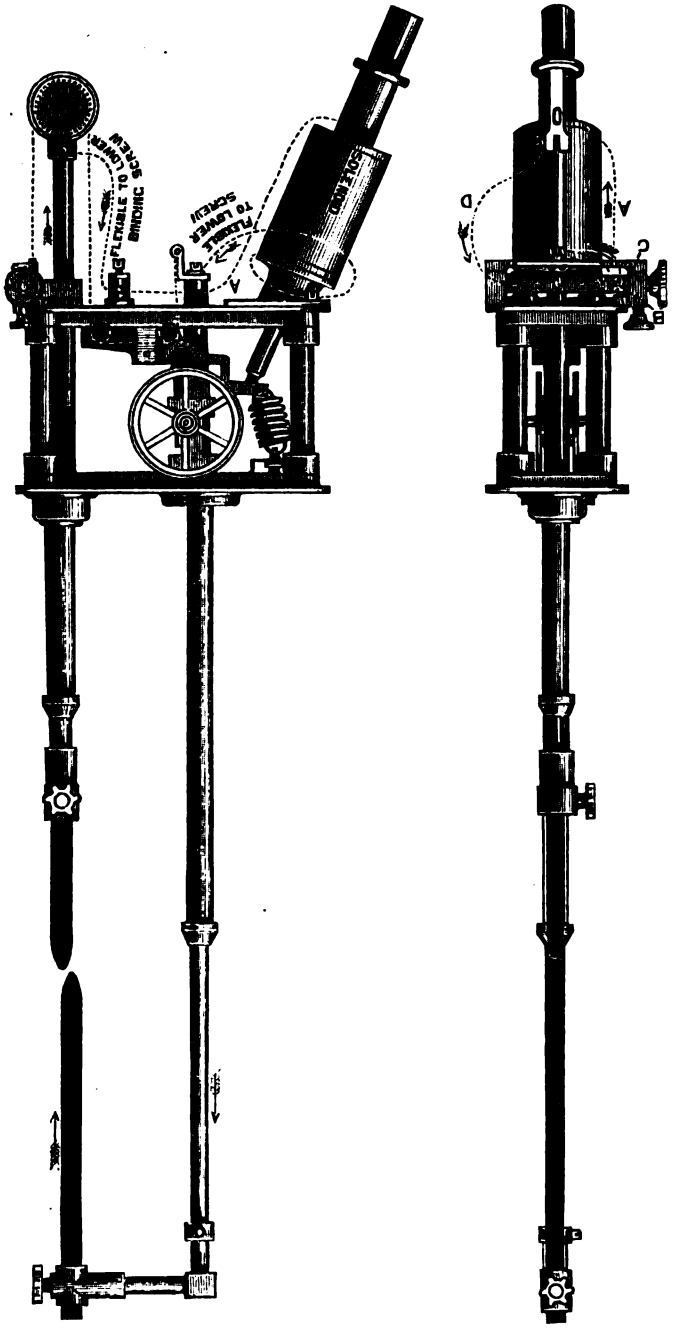
CROMPTON'S SEARCH LAMP.

We illustrate this week what will no doubt be interesting to our readers—namely, a very simple search light, designed and constructed by R. E. Crompton and Co., of Chelmsford. Up to the present time the lamps for search lights have been hand-regulating; but Messrs. Crompton and Co. have perfected a self-regulating differential focussing lamp, which has been satisfactorily tried under varying conditions. The lamp is a modification of the well-known Crompton-Crabb arc



FIGS. 1 AND 2.—The Crompton-Crabb Self-Regulating Differential Focussing Lamp for Holophote.

lamp. It combines not only the usual excellent principles of the D D lamp, but is also provided with a later patent compensating lever, by which arrangement the amount of carbons consumed does not alter nor disturb the equilibrium of the lamps, and a very small movement of the solenoid, or armature core, gives a comparatively great travel to the carbons, and thus makes the lamp very sensitive. To bring the focus of the lamp in the focus of the parabolic mirror, it is adjusted by a milled-headed screw in the vertical, and by a similar screw in the horizontal direction. The whole of the working parts are below the carbons, and enclosed in a light wrought-iron casing, with sliding door on both sides, to give access to the parts of the lamp. The case is fitted to the rolled steel tube, fitted with a strong gun metal casting on both ends. In one end is mounted a 24in. diameter Chance parabolic mirror (this is a decided advantage in cost to the usual

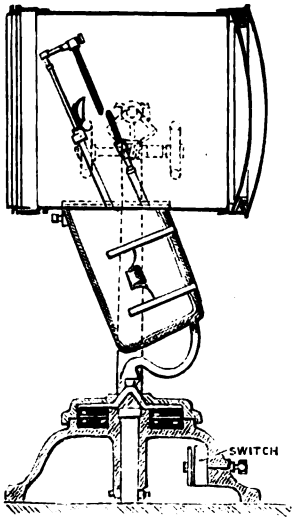


FIG. 3.—Vertical Section.

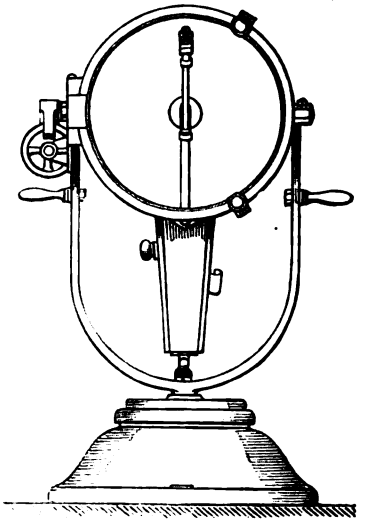


FIG. 4.—End View.

dioptic lenses). The mirror is fastened and held in position with springs at the back, to prevent injuries by concussion due to the firing of heavy guns. At the other end is a strongly-hinged gun-metal door, carrying a thick plate glass front, provided with a neat and simple fastening for opening and closing. The

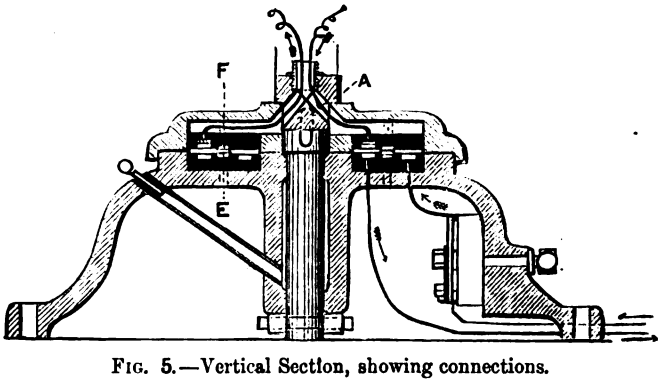


FIG. 5.—Vertical Section, showing connections.

steel cylinder is fitted with gun-metal trunnions, which rest in gun-metal bearings held in a strong wrought-iron fork, which is fixed into a movable cast-iron top and passes through into the lower cast-iron base for turning in the horizontal plane. On one side of the trunnions is fixed a quadrant and worm

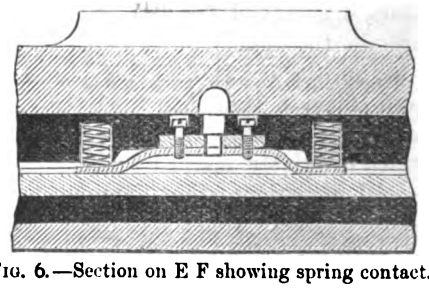


FIG. 6.—Section on E F showing spring contact.

for raising and lowering in the vertical through a certain angle. In the cast-iron base are fixed the contact rings and sliding brushes to supply the current to the lamp in any position. On the outside of the base is also fitted a switch, on either side of which the cable enters, and is connected up as shown.

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The drawing is so clear as to need no further detailed description; and we venture to say it is very characteristic of the above firm to give to the profession full descriptions of everything they manufacture. We understand that Messrs. Crompton and Co. manufacture search lights fitted with 24in., 20in., and 16in. diameter mirrors. They have at present two in hand of 25,000 candle-power each, for the ironclad "Aquidaban," which is being built for the Imperial Brazilian Government by Messrs. Samuda Brothers. Besides the two arc lamps, the ship is being fitted throughout with incandescent lamps by Messrs. Crompton and Co., the general arrangement of which we hope shortly to be able to place before our readers.

ALTERNATING CURRENTS.—MUTUAL-INDUCTION.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 259.)

The interesting experiments of Mr. Willoughby Smith on the effects produced by inserting masses, or as they were described screens of metal in the field of two coils on their mutual induction illustrate this proposition. Though the undulations of the primary electromotive force were not in this case harmonic, but were produced by the mere commutation of the poles of a battery, yet there is no doubt that the effects produced in the secondary coils by this mode of generation would approximate to those illustrated here. From the figure it is clear that a large increase in the value of M will greatly diminish the proportion which h bears to e, but unless L′ is largely increased, the increase of M will not largely alter the value of CE, though h be greatly diminshed, and f depends on CE and L′. In the lecture which the writer had the good fortune to hear from Mr. Willoughby Smith the chief omission seemed to be that of a dynamometer in the primary coil. It is highly probable that a great falling off would have been noticed in the reading of such an instrument, when the metal was placed in the field, even when the dynamometer in the secondary circuit showed no falling off of current. The faulty use of the idea of *screening* would have been made very manifest by such an experiment, for it would have seemed as if the screen had been enabled to *maintain* the effect of the *radiation* on the recipient circuit when the source of the radiation itself had become weaker. I have, in fact, illustrated this point in an experiment. A battery and electric tuning fork were joined in circuit with the primary coil of a Ruhmkorf apparatus of which the usual vibrator was constrained in position to maintain contact, the tuning fork taking its place as vibrator. In the scondary circuit was a Bell telephone. The core was removed and the apparatus set to work, both the tuning fork and telephone singing in unison. On pushing the core into its place in the centre of the coils, the intensity of the tone of the telephone was increased, but that of the tuning fork was diminished. The period was $\frac{1}{430}$ of one second, the tuning fork giving the A above tenor C. Probably a lower note would have increased the effect observed. To render the effect on the tuning fork more evident, it is well to silence the telephone. This can be conveniently done by holding it mouth downwards and burning a wisp of paper about 6in. beneath. On the other hand, the figure and the formulæ show that when the period is diminished, other things remaining the same, both the effective electromotive force in the primary and that in the secondary circuit grow smaller compared with the impressed electromotive force. But the equation (γ) indicates that when T is diminished, *i.e.*, when the alternations become more rapid, the relation of the current in the secondary circuit to that in the primary circuit becomes greater; thus, in that part of Mr. Smith's experiments which dealt with an augmentation of the rate of alternation, the energy could hardly be said to be *screened* when a dynamometer in the primary coil would have demonstrated a greater falling off in the current in that circuit than occurs in the secondary circuit. To describe such an effect as due to screening would be as if one suffering from the radiation from a grate should pull between himself and it a screen, which, by being drawn into the middle position, should, by suitable mechanism, cause a bucket of water to be emptied into the fire, and were then to declare that the screen had stopped the radiation by virtue of being a screen.

[The above forms the completion of the chapter on "Mutual Induction," which was unavoidably crowded out of our last issue.]

(TO BE CONTINUED.)

THE LATE DR. DAVY.

It is with extreme regret that we record the death of Dr. Davy, whose name is so well known to our readers from the investigations of Mr. Fahie. In recognition of Dr. Davy's pioneer efforts in electric telegraphy, the Society of Telegraph Engineers had quite recently elected him a honorary member. Dr. Davy had received this information by telegraph but a few days before his death, which took place at Malmesbury, Victoria, on the 28th January. It will be unnecessary for us to give in detail the incidents of Dr. Davy's life, inasmuch as they were given very fully in a biographical sketch in our issue of July 28, 1883. Dr. Davy was born in 1806, and hence, at the time of his death, was seventy-nine years of age. As early as 1836 he appears to have conceived the possibility of an electric telegraph, and seems to have had an excellent knowledge and thorough grasp of the properties of electricity. A full account of his work has been given by Mr. Fahie in our pages, and we only regret that Dr. Davy's claims to recognition were not sooner admitted. In 1839 Dr. Davy went to Australia; he was one of the founders of the Royal Society of Victoria, and an active worker among its members.

CENTRAL STATION LIGHTING.

The following is an abstract of a paper read by Dr. Fleming, based upon his experience in America. The information contained in this paper is on points not of very general knowledge respecting central station lighting, its difficulties, and its successes, with respect more especially to the incandescent lighting in New York. The facilities of Dr. Fleming were exceptionally good, and the results given in this paper are not merely those of a hasty visit, but of weeks of careful scrutiny, and hence may be taken as absolutely accurate. Things that chiefly interest us in the history of all great experiments are the difficulties that have arisen and the methods by which they have been overcome. It has been well said that if Faraday's "Experimental Researches in Electricity" is a valuable book, yet Faraday's experimental failures in electricity would be almost as valuable, and accordingly Dr. Fleming mentioned first some of the difficulties in the problem of distributing large currents for illuminating purposes. He then said:—

When Mr. Edison had completed his lamp and his dynamo, which he had practically done some time before the Paris Exhibition, he knew that between him and the realisation of his project of central station lighting there stood the great difficulty of the underground conductors. He realised that the maintenance of an equal potential over a large conducting network buried in the earth and the necessary insulation of the same were not easy things, but involved stupendous difficulties, which no small scale experiments could overcome; and the history of his mind on this subject is most interesting as gathered from the study of his patents. He recognised that in order to give his station a chance of success he must pitch upon some locality where there was as great a density of consumption of light as possible—that is, as many lights per acre or as much vertical lighting as could be obtained; and he selected a spot in the extremity of Manhattan Island. He was intimately acquainted with the various projects, whose name is legion, for underground conductors, and he recognised most of them as branded on their foreheads with the stamp of impracticability. All such schemes as using the metallic sheath of an insulated conductor for a return were tried and

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abandoned; cables dragged through metal or stoneware pipes, troughs or channels, or laid in wooden casing, were examined and condemned. He finally selected to use copper rods, segment shaped, and put, together with an insulating material of bitumen and oils, in an iron pipe. These were joined together in 20ft. lengths by copper screw connections, the joints soldered. The reason he did this was because in city streets it is almost impossible to get a clear run free from other pipes in which to lay a conduit. If anyone not familiar with sewer work only looks for five minutes at a street dug up it will be seen that the entanglement of pipes crossing at various levels, and crossing out of the street under the pavement renders it impossible to use any method which cannot easily and cheaply be accommodated to the instant necessity of a change of level in laying down.

The first difficulty met with was in soldering the connections of the 20ft. lengths. The joints had to be electrically perfect, and the getting of a good joint in two highly conducting copper bars, which run away with the heat as fast as you put it in, and the countless difficulties of insulation at the joint brought the workmen sometimes to despair. Edison himself was down on his knees in the trenches night after night until the job was got through, and thirty or thirty-five miles of underground conductors laid. Now came the question of the feeders. As you know the current has to be got into this double network at one side in certain places and got out again at the other, and the question of *how* and *where* to attach the feeders was the next obstacle. Edison at first thought that the problem could be solved mathematically, and so it can by a method due to Maxwell; but the mathematical solution only applies to a given case, whereas, in the real case the points of consumption are continually shifting, and the thing wanted is a practical solution. At last he did the thing experimentally. The probable consumption was first estimated as closely as possible, and the probable localities of lamps represented on a plan, and by experimental methods, the best localities found at which to supply the current. From the central station twenty feeders go out to these points, and at all the street crossings are circular junction boxes, into which the sixteen ends of cable from four sheets come to two copper rings + and −, and the feeders are attached to these. As soon as the station was started, on September 4, 1882, difficulties began. First, it was found that the consumption of light shifts, the centre of gravity of consumption varies, the chief bulk of the lights are going in one place at one time, and at another at the next hour. Hence they require to have a command over the point of supply, and to do this they have had to throw out of use six of the feeders, and only use 14, not always the same 14. What this proves is that plenty of spare feeders are required, so that if the potential is found to be low at one spot it can be brought up, and if high lowered. They would have preferred, if possible, to add spare feeders. This necessitated a little too much load on the feeders, and one day all the main safety catches went, and put the station out for four hours, but this is the only occasion in two years and a half. Next it was found that the conducting network was too rigid, and broke or got damaged by the stresses brought upon it by traffic in the streets. Owing to the varying loads on the surface of streets, and the unequal density of the soil beneath, in some places hard and compact, and in other places where it has been recently opened, spongy, it is essential that the conducting system shall have a power of accommodating itself to small displacements without injury. Gas and water pipes do this by the method of attachment. The first methods of coupling the 20ft. lengths were too rigid. Then, when many mishaps had occurred, Mr. Edison devised a cup and ball joint at the coupling box, which gives a certain play to the skeleton, and gives the necessary elasticity. He told me it was a perfect success. Next as to the insulation. The compound used is really a stiff fluid; and when the pipes containing the two copper rods are bent the flexure in some cases brings stress to bear, which makes the rods gradually change their place in the material and come together. It is this very quality of bitumen being really a fluid that makes it undesirable to lay down cables in bitumen, unless the cables are kept in position by solid insulating bearers or bridges. The result of this was that in some cases they had dead crosses both in mains and in feeders. The methods now adopted are to wind the bare rods spirally with string, then put them together and wind string over the two, then put them in iron pipes and force in the insulating compound when fluid, and thin danger from dead crosses is obviated. There is another cause of cross leakage, viz., conduction through the bituminous compound as the conductors get warm; but of this I will not speak, as I am now engaged in a series of experiments in the conducting power of oil and such like bodies at high temperatures. Lastly, accidents happened from want of mechanical strength. When navvies have to take up streets they are not too choice where they drive their pickaxes, and in many cases they drove them through the iron pipes; but as occasion offers the thin iron gas pipe first used is being exchanged for thicker iron steam piping, and this result prevented. Experience therefore has shown the need for, 1st, elasticity in the network; 2nd, spare feeders; 3rd, great mechanical strength; 4th, highest perfection of insulation in both mains. The insulation of the + and − side is measured every hour, and the exact amount of leakage estimated, and its locality ascertained. This is never allowed to exceed one lamp over the whole system. With regard to future improvements there is room for much. Enough has been said to show you that it has not been easy work to devise a system of underground conductors for large currents of even 100 volts pressure, and it will be more difficult still to devise a system on an equally large scale if the working pressure is higher, since the breaking stress tending to carry electricity through the dielectric varies as the square of the electromotive force.

It is only within the last year that the problem can be said to have been approximately solved, even for incandescent lighting. Experience has also brought forward the necessity for perfectly simple means of getting each street length isolated for testing without digging up streets, and for easy replacement of safety catches at each end. This is now done by the cast iron box, closed by a manhole lid, at each street crossing. Each positive main is joined on to the positive copper ring by a fusible slip, and each negative to the negative ring. Experience has shown the need for the most perfect contacts at these places, since a loose contact that would generate little noticeable heat with a 100 ampere current creates a very different state of things with a 500 ampere current. One thing is certain—viz., that the laying of the two conductors in one tube is a difficulty, and it would be better to have them separate. Dead metallic crosses would then be impossible, as even if both mains are earthed the polarisation resistance is considerable. We may pass next to some criticisms on the chief details of the generating station. What they did was to buy two houses in Pearl-street (something like Thames-street), gut them, put in iron girders and struts, build chimney stacks, and put in Babcock boilers, Porter-Allen engines, and six of Edison's big dynamos, driven direct. They put the boilers downstairs, and the heavy engines and dynamos upstairs, and in this they made a mistake. The vibration is excessive, but it does not matter. On this question of injunction for a nuisance they enjoy special advantages. The elevated railway runs down the street, and nothing can be a greater nuisance than that is. I made special tests on the economy of their boilers and engines, which showed fairly good results but left plenty of room for improvement. The result of investigation into the lamp hours of the lights in this installation showed that the maximum does not reach 1,000 hours per annum. Now, between the engine cylinder and the lamp you have the following losses of energy:—Friction in engine and dynamo; eddy currents in iron of armature and bolts; eddy currents in copper rods of armature; loss in mains and feeders; loss in badly fitting safety catches, lamp sockets, house wiring, switches, &c.; and the result is that of 100 parts of power indicated on the piston, 48 per cent. only gets dissipated in the filament as light and heat. The other 52 per cent. is totally lost, of which more than 40 per cent. will be

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accounted for outside the mains, and even with the present boilers represents a loss of 1,880 tons of coal a year. Here is a gap for engineer electricians of the future to fill up. There is a more striking fact than this. The horse-power hours of energy dissipated as light and heat in all the filaments of all the 12,600 lamps in six months is 500,000. This is equal to a million million foot-pounds. The coal used in six months is 1,887 tons = 4¼ million pounds nearly. Each pound of coal contains 12,000,000 foot-pounds of energy. Hence nearly 50,000,000,000,000 (*fifty* million million) foot-pounds of energy are used to get *one* million million as light and heat, or 49–50 of the total energy of the coal is irrecoverably lost. The second law of thermo-dynamics forbids our getting back the whole of this, but there is a vast fraction which can be recovered. Can we ever hope to bridge this gulf and get the energy out of the coal direct, and, if so, where is the genius who is going to show us how? The world waits breathless for his advent.

The author thought it would be advantageous to use compound machines. Referring to meters, he said: Meters deserve one word. I do not think, from what I know of the zinc voltameter meter that it is the meter of the future. We are still waiting for an accurate mechanical meter, not dependent on complicated gear, and capable of being made for £3 or £4, or less; so that a rental of 1s. a quarter may pay the interest on capital outlay on meters, and provide a little something for a meter sustentation fund, for pensioning off and replacing old and decayed meters. My determination, of the accurate lamp hours of the station has enabled me to determine the average hours' burning of each lamp per year, and it is about 900 hours. Now, this is very interesting and important. It shows that in a district composed of shops, warehouses, restaurants, banks, &c., when people tap and use the light as they like, the average lamp use per annum is less than 1,000 hours. Now, I do not believe that a residential district would double this, and that therefore all those estimates for cost of electric lighting of towns based on 2,000 hours and upwards are misleading and incorrect. In one estimate, which was drawn up for the town of Sheffield for 10,000 lamps, the draughtsman assumed as the basis of his calculation 30,000,000 lamp hours per annum. At the end, however, he says this is probably too much, and finally surmises that half that amount would be right. Any estimates of cost as compared with gas are in error if they assume much more than about 1,000 hours per lamp per annum.

I must now say one word on the subject of multiple conductors. In July, 1882, a patent was taken out by Dr. Hopkinson, and followed by two others by Mr. Edison in December, 1882, and June, 1883, for a system of multiple conductors, in which combined parallel and series grouping is used for dynamos and lamps. You all know about it, so I need not describe it. Its advantage is that it effects a saving of copper over simple parallel in the proportion of $\frac{M}{2(M-1)^2}$ to unity, when M is the number of conductors. Practically for three conductors it only saves about 30 per cent. on the whole.

They have this system working in thirteen places in America, and in three of them the triple conductors are underground, and in one tube (Newburgh, Brockton, Fall River). I had a long and special talk with Mr. Edison on the extension of this. To my mind one of the most hopeful directions for inventors to work is given—that ground is too expensive in a district to admit of a central station, nevertheless, we can bring in from a distance to a central room current of high potential by light mains, and there split up the potential and distribute it. It can be done by multiple conductors without secondary batteries or secondary generators. The problem of the future is not central stations, but excentric stations, getting electricity generated on cheap land, and bringing it in by highly insulated feeders at high potential to places of division.

One word in conclusion about the Board of Trade model Provisional Order. That has got to be remodelled, like the Act. When I explained to Mr. Edison the delightful intricacies of A and B districts—fines for not keeping the potential constant, choice of lamp left to customer, and so forth, he simply laughed. A model order, if orders there are to be, must be drawn up with the assistance of those who have studied central stations in operation to obtain conditions which are consistent with the actual difficulties which are met with.

Although we in England seem to drag behind, I yet believe that the interesting and fascinating problem of publicly distributed electricity will be solved some day for ourselves on English soil. We call our practical electric units after the names of great investigators. Three out of the eight are named after Englishmen; and it is impossible to doubt that the country of Watt, Faraday, and Joule has in it engineering and electrical skill to overcome the difficulties to which I have most briefly alluded; and, unless there is some radical impracticability about the whole problem to grapple successfully with it, and give us, in the dying words of Goethe, "More Light."

LEGAL.

In the Chancery Division of the High Court of Justice on Monday, 12th January, 1885, Vice-Chancellor Sir James Bacon gave judgment "In the Matter of the Companies Acts 1862 and 1867, and in the Matter of the Mediterranean Extension Telegraph Company, Limited."

The VICE-CHANCELLOR said: I think the difficulty in this case is more apparent than real when the constitution of the company comes to be considered. This was a joint-stock company, formed by contribution from the several shareholders, and there was a power to increase the capital of the company. They resorted to that power, and they did increase the capital by issuing preference shares. They did it, and I suppose they could do it upon no other terms than to raise the dividend up to 8 per cent, and so, while the company was a going concern, that went on. Now, the 88th section, upon which most of the discussion has arisen, seems to me to be perfectly plain. It is this: No dividend shall be payable except out of the profits arising from the business of the company. £7,200 paid by the Government was part of the profits of the company. Then it provides that the profits shall be estimated independently of such sum as the Board may think proper to set aside as a reserve fund to meet contingencies, or for equalising dividends, or for repairing or maintaining the company's telegraphs or works, or for the purchase of, or any expenses connected with, any patent of the kind mentioned. Now, the meaning of that is, when we come to take an account of the profits, which is what we have earned and what we have got, the profits shall be calculated. But, we will reserve money enough in the till to enable us to carry on other business. One thing will be the equalisation of dividends. If the 8 per cent. had been paid and the 3 per cent. had gone without payment, which upon many occasions it seems that it did, then this reserve fund might be applied for that purpose. The power to redeem the preference shares applies very well to a going company, but it can have no influence or operation whatever when the company is bankrupt, insolvent, and wound up. Now, that state of things has happened, and the accounts are taken, and it is ascertained that there is this money in the till, as I call it. There is a sum to be divided among the shareholders, and for the purpose of that division there is no difference between preference shareholders and others. It is no longer dividend they are going to divide. There is no necessity for resorting to that to equalise dividends for past years when no profit was made, but the money as it stands there is divisible among the shareholders of the company, there being in that respect and for that purpose no difference between preference shareholders and any other shareholders. The only difference was that the preference shareholders got 8 per cent. while there were the means of paying them 8 per cent. When the catastrophe happens, and there is no possibility of there being any gain, profit, or anything else out of which the dividends can be paid, for they can be paid out of profits, then, all that remains to be done is to wind up, to realise what remains, and to divide it among the shareholders equally. The Chief Clerk dealt with it, as I understand, in this way. He decided that the preference shareholders had no preferential claim against the capital, but that, as shareholders, they are entitled to participate in the reserve fund. In my opinion that is the very plain justice of the case, and it is perfectly consistent with every stipulation contained in the articles. The articles authorising the enlargement of the capital gave an advantage to certain persons while the thing was going on, but there is no power given where bankruptcy has happened, and nothing remains but to wind up the concern and divide amongst the parties the fund to which they are entitled. Their rights as shareholders are equal; their rights to receive dividends, when dividends were payable, were different. But that state of things has ceased to exist, and in my opinion the fund is divisable *pro ratâ* among all shareholders, original and preferential, and there is no ground whatever for making any other distribution of the fund which remains.

Mr. MILLAR: The surplus assets of the company will be so dealt with, including the reserve fund. We had better state that.

Mr. BUCKLEY: Certainly.

The VICE-CHANCELLOR: They are all one. It is money in the till, as I have said. It is the property of the company to be divided among the owners, and the owners are the shareholders in equal shares.

Mr. MILLAR: The costs of all parties will come out of the estate.

The VICE-CHANCELLOR: Yes.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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SOLDIERS AND THE TELEGRAPH.

At a serious crisis like the present, when the nation is suffering acutely by reason of ill news—news which has travelled, this time none too quickly, partly by hand but chiefly by the medium of Electric Telegraph—it may be useful, as it certainly is natural, that we should once again turn our attention to the functions of that now indispensable adjunct of modern warfare. To say that the telegraph is indispensable is to settle the question of its utility; and this being so all the grumblings in the world on the part of generals in command will not alter the fact. Officers have been heard to say that it is that confounded Telegr aph that makes military operations so difficult; but those very officers, our informant assured us, were particul arly anxious to become better acquainted with their aversion, and to compel their men to follow their example. The truth seems to be that from a soldier's point of view the telegraph is very good for him, but bad for the civilian—or rather, bad for the soldier when used by the civilian. It also hampers the General with orders from home when he would greatly prefer to act on his own judgment—many a good campaign being spoiled by the civil big-wigs at home whose interference is made far too easy by the swift messenger on wires.

It is perhaps not worth arguing against a prejudice which is probably rapidly disappearing under the lessons of experience. It may be worth while to remark, however, that interference from home is no new thing, as the history of the Peninsular War only too plainly reveals; and although our generals in India used to have a freer hand they were not free from responsibility. Responsibility never sat very heavily upon them, it is true; but, on the other hand, wars are nowadays undertaken and planned on the clear understanding that communication with central authority will be maintained uninterrupted. And this alteration brings some clear gain to recommend it. In India the mutiny would not have reached the formidable dimensions it actually attained had the telegraph stretched its friendly arm so far at that time; and in this Egyptian business, where the unforeseen, which is always to be reckoned with in warfare, has actually happened, the original expedition must have been much larger, and the uncertainties much greater had there existed no instant means of demanding reinforcements. Then, again, the purely military services rendered by the telegraph, not only in the field but for keeping touch of outlying posts and reserves, far outweigh the small annoyances caused by that munificent patron of the telegraphs the war correspondent of the newspapers. Indeed, the present Commander of the British forces in the Soudan is said to have got rid of the annoyance by well-nigh suppressing the chief cause of it—not the special wire, but the special correspondent.

On the whole, therefore, it can be proved, if any proof were needed, that while it has had to accommodate itself to the facts of the Telegraph, in the hands of enemies as well as of indiscreet friends, modern warfare has been immensely the gainer by having under its control a medium for the despatch of orders and intelligence so swift in its operation that commanding officers are everywhere within sight and hearing practically of the whole army, as well as of the country for which it is fighting. So far from bearing it any ill-will, military men should, we submit, encourage the Telegraph by every means in their power. We are glad to know that in certain arms of the service the value of the Telegraph has been fully recognised, and that, for example, the Royal Engineers are as a body all expected to be able to work the Morse system when required. The fact that a not inconsiderable number of them have from time to time been employed in the Postal Telegraph service indicates that they have attained proficiency in this part of their important duties. But the Royal Engineers cannot be everywhere; they have other special duties quite as important, often more so, than erecting telegraph lines and transmitting messages. With the advance of the British Army in force towards Khartoum or on Berber, as the case may be, it is conceivable that even if a wire were to follow its movements, there might at certain points be nobody capable of operating upon it. We should be glad to be undeceived if we are mistaken in this; but unless there can always be spared a certain number of Royal Engineers to accompany every separate body of advancing troops, telegraphic communication with the base of operations cannot possibly be kept up. Any way, it seems to us that no harm would be done, and a great deal of good might accrue if a knowledge of the telegraph, which is considered indispensable for Royal Engineers, should be extended to a selected number of every regiment and of every arm of the service.

We urge this with a full knowledge that the Electric Telegraph does not, and cannot always, follow every step of the soldier's march. But visual signalling might; and if it does not it is because there are not a sufficient number of competent signalmen to perform the duty. Visual signalling is closely related to electric signalling; the manner, though not the medium, is often the same, and in any case the best visual signalmen, as the Post Office Volunteers have shown, are men who are most experienced in electrical signalling. The helio-

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graph is said to be impracticable in the desert because of the *mirage;* whatever signalling is done must therefore be carried on by flag waving, or some similar device. That this is capable of further development and extension we have not the slightest doubt ; and in favourable circumstances messages might be passed on in that way over long distances at a speed slower indeed than the electric telegraph, but vastly quicker than the fleetest horseman could travel. The code is the same ; and after learning its application to one system its adaptation to the other is said to be very easy. By beginning with the electric telegraph there would perhaps be this advantage, that signalling by night, supposing the flashing system not to be available, would still be possible by means of sound. Lord Charles Beresford with a hammer and the engine boiler, and Sir Charles Wilson with a stick and a drumhead or a provision chest, could have spoken to each other quite freely through that anxious night when two miles of Nile river separated them, if only they had learnt the Morse code and how to utilise it. England's wars are almost always out of the beaten tracks of civilisation, and the necessity for being independent of local means of communication is more incumbent on her armies than upon the armies of any other country. The rank and file of English soldiers should be taught the Morse signalling more extensively than is the case at present; and most certainly both visual and electrical telegraphy should form part of every British officer's education.

CORRESPONDENCE.

ELECTRO-MAGNETS.—PROF. ROWLAND'S ADDRESS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : A letter appeared recently in *The Electrician* asking for information about the design of electro-magnets. An answer which appeared was useful as far as it went, but contained no allusion to the magnetic properties of iron. I propose, without interfering with your proposed course on dynamos, to say a few words on this subject, so far as it has come my way.

The only work which professes to deal with the construction of electro-magnets is by Th. Du Moncel, Paris, 1882. It is not of much practical use, on account of the antiquated notation and point of view generally; and its discussions are restricted to cylindrical bars, whose length is 11 or 12 times the diameter. But I have little doubt that a modernised edition of this work would be of much practical utility. The want of generality of view impairs its value for scientific purposes.

It is convenient practically to divide the subject of electro-magnetic induction in iron into three parts :—

1. Properties of the iron itself;
2. Properties of the shape of the iron;
3. The combination of 1 and 2.

Rowland's paper on "Magnetic Permeability, and the Maximum of Magnetism of Iron, Steel, and Nickel,"* gave the first complete account of the nature of the magnetic properties of these metals themselves, and rendered rational discussion of the subject possible. Rowland's experiments were made on rings, which formed closed magnetic circuits of the metal, and thus eliminated the influence of shape. ". . . The results are expressed and the reasoning carried out in the language of Faraday's theory of lines of force." The elementary law assumed is similar to Ohm's law.

The experiments are directed to the determination of a quantity, μ, which expresses the ratio of the field within the iron to the ordinary magnetising force. Rowland's results consisted of expressions for μ in terms of the magnetism per unit area, Q in the paper, $\mathfrak{B}$ as I write it. Two further papers by Rowland appeared in *Phil. Mag.*, Vol. L. (1875), on magnetic distribution. Here the idea of magnetic resistance is formulated, but is only employed in the construction of the theory of distribution.

My attention was directed to the subject in examining the theory of electro-magnetically driven tuning forks. I found that the books did not touch the subject, and there were no means of deriving the properties of magnets from their arrangements. All the theoretical formulæ were practically untried, and depended on uncertain assumptions far too much for practical purposes.

In a paper sent to the Royal Society (abstract in *Proceedings*, No. 223, 1883) I developed a means of defining the properties of electro-magnets under given excitation which is in principle the same as that I still use. This consisted of defining the "magnetic permeability" of the electro-magnet as the ratio of the magnetic induction in it to the external magnetising force.

This was the first attempt within my knowledge to deal with the branch of the subject which I have called (2) above from a practical point of view. Rowland's work had disposed of (1), or shown the way to do so.

Theoretical estimates of the magnetic resistances of different parts of an ordinary magnetic circuit were made in the paper referred to. As far as I can now judge, the estimates of the air resistances were all somewhat too large.

In a paper "On Magnetomotive Force," *Phil. Mag.*, New Series XV., p. 205, March, 1883, and subsequent papers, I have reduced these considerations to a practical system. Magnetomotive force is difference of magnetic potential, just as electromotive force is difference of electric potential. Lately, as will be seen, Rowland appears to have defined magneto*motor* force differently. I define magnetic resistance as,

$$\rho = \frac{\text{Difference of magnetic potential}}{\text{Lines of force per unit area}}.$$

The resistance according to the strict analogue of Ohm's law would be

$$\frac{\rho}{S} = \frac{\text{Difference of magnetic potential}}{\text{Total lines of force}}.$$

As ρ is the more convenient quantity to deal with, S is struck out on both sides. (S = area.)

Now, if we know ρ we can tell what amount of induced magnetism will be excited by given potential, and *vice versâ*.

(Potential $= 4\pi C n$ $\quad 10 C n =$ ampere turns.*)

My experiments have been mainly directed to tabulating ρ in different cases, and I have obtained in this way general expressions by which we can calculate its amount in certain cases.

In the paper on magnetomotive force I first employed the principle that the resistance of a circuit is the sum of the resistances of its parts, which was the first practical attempt to deal with subject (3).

My formulæ for cylindrical bars are given in *Phil. Mag.*, June, 1884, p. 532. I have since been led to doubt the applicability to very short and thick bars.

ρ = magnetic resistance.
l = length of bar.
r = radius of bar.
$\mathfrak{B}$ = lines of force per unit area in equatorial section of bar.

$$f = \frac{\text{focal length of bar}}{l} = \frac{4\pi M}{l \times \text{lines of force.}}$$

M = moment.

μ = permeability of metal: may be represented by Rowland's formula, or more simply by such a formula as

$$300 + 2000\left\{\sin\frac{\mathfrak{B}^\circ}{100} + \tfrac{1}{4}\sin\frac{2\mathfrak{B}^\circ}{100}\right\}$$

(See paper in *Phil. Mag.*, Feb., 1885.)

$\mathfrak{B}$ ranges from 0 through a value (5,000 or 6,000), where the metal is most easily magnetised, up to a saturation point of about 18,000.

* *Philosophical Magazine*, XLVI., Fourth Series (1873), p. 140.

* With respect to the origin of this phrase. In a letter in *The Electrician*, December 9, 1882, I called 10 C n "coil amperes." In a paper on the same subject shortly after Mr. G. Kapp spoke of "ampere turns," a phrase which I have always used since. I call C n "current turns."

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The winding is supposed uniform from end to end of the bar. The formulæ are—

$$\rho = \frac{l}{\mu} + \cdot 37 \times 10^{-\cdot 0061 \frac{l}{r}} *$$

$$\text{Ampere turns required} = \frac{10\,\mathfrak{B}\,\rho}{4\,\pi} \quad (\pi = 3\cdot 1416)$$

$$f = \cdot 650 + \cdot 440 \frac{\rho}{r}$$

$$\mathrm{M} = \frac{f\,l\,r^2\,\mathfrak{B}}{4}$$

The use of these formulæ may be best shown by an example. I will select one of the bars for which the formula was established, reckoning back, as if the behaviour of the bar were to be found.

$$l = 28\cdot 55 \text{ centim.} \quad r = \cdot 938 \text{ centim.}$$

We will suppose that the required value of $\mathfrak{B}$ is 10,000, that is a powerful magnetism, but below the point where the resistance due to saturation begins to be sensibly felt.

To find μ, when $\mathfrak{B} = 10{,}000$

$$\sin \frac{\mathfrak{B}^\circ}{100} = \sin 100^\circ = \cdot 985$$

$$\tfrac{1}{4} \sin \frac{2\,\mathfrak{B}^\circ}{100} = \tfrac{1}{4} \sin 200^\circ = -\cdot 085$$

$$\cdot 900$$

$$\cdot 9 \times 2{,}000 = 1800$$
$$300$$
$$2100 = \mu$$

$$\text{and } \frac{l}{\mu} = \cdot 0136$$

The second part of ρ is calculated by logarithms.

$$\log \cdot 37 = \bar{1}\cdot 568$$
$$\log r = \bar{1}\cdot 972$$
$$\bar{1}\cdot 540$$
$$\cdot 0061 \frac{l}{r} = \cdot 186$$
$$\bar{1}\cdot 354 = \log \cdot 226$$

adding the two parts of ρ, $\cdot 226 + \cdot 014$

$$\rho = \cdot 240$$

To calculate the ampere turns required,

$$\log 10 = 1\cdot 0000$$
$$\log \mathfrak{B} = 4\cdot 0000$$
$$\log \rho = \bar{1}\cdot 3802$$
$$4\cdot 3802$$
$$\log 4\pi = 1\cdot 0992$$
$$3\cdot 2810 = \log 1910,$$

which is the number of ampere turns required.

The ampere turns actually employed in an experiment which gave $\mathfrak{B} = 10{,}210$ were 1894.

The calculation of f is required for the moment. f is generally a little less than the distance of the poles, as commonly defined, divided by length of bar:

$$\log \rho = \bar{1}\cdot 380$$
$$\log \cdot 440 = \bar{1}\cdot 643$$
$$\bar{1}\cdot 023$$
$$\log r = \bar{1}\cdot 972$$
$$\bar{1}\cdot 051 = \log \cdot 112$$
$$\cdot 650$$
$$f = \cdot 762$$

To calculate M, the moment,

$$\log f = \bar{1}\cdot 882$$
$$\log l = 1\cdot 456$$
$$\log r^2 = \bar{1}\cdot 944$$
$$\log \mathfrak{B} = 4\cdot 000$$
$$5\cdot 282$$
$$\log 4 = \cdot 602$$
$$4\cdot 680 = \log 47{,}900 \ldots \mathrm{M}$$

The value directly found for the moment when $\mathfrak{B} = 10{,}210$ was 48,400.

It must be remembered that the constants of the formulæ are determined so as to agree pretty well with facts through a wide range. Very close agreement with single values cannot be expected.

I have not as yet made experiments on magnets with pole pieces. But there can be little doubt that these will be intermediate in behaviour between rings and bars. I may probably address some remarks to you on dynamo machines, suggested by these considerations, which will not, I think, interfere with your proposed course on the construction of dynamos.

I must now make some remarks on the report of Rowland's British Association address on dynamo machines, and especially on that part of it which is reported in your number of October 25, 1884. The report is so meagre as to be almost unintelligible. It is necessary to allude to it, because it appears that Rowland's present methods are following the same lines that I have been pursuing.

Near the bottom of p. 535 we find the term magnetomo*tor* force. It will be remembered that I had assigned the term magnetomo*tive* force to difference of magnetic potential in March, 1883. In fact, however, I have found the old term, magnetic potential, preferable in practice.

It is not possible to make out from the report precisely what Rowland's magnetomotor force is intended to be. It is first described as being proportional to current turns. Then the total number of lines of forces, ($\mathrm{S}\,\mathfrak{B}$ in my notation) is described as proportional to the current turns and inversely as the magnetic resistance, which is exactly as I state it, except that I keep the potential in the numerator to save the analogy to Ohm's law. Then the different parts of the resistance are enumerated. The air resistances appear to be estimated in a manner nearly according with one of the rules in my Royal Society paper, and the different parts of the resistance are directed to be added together in the manner practised in my paper on magnetomotive force, and subsequent papers. But the final quantity with the current turns in the numerator and the sum of the resistances in the denominator is spoken of again as being the magnetomotor force, instead of being proportional to the number of lines of force, as it probably should be. Then I remember that Rowland's original "magnetising force" was current turns per unit length, and I feel uncertain whether the "magnetomotor force" may not be intended to have a linear quantity in the denominator. We must wait for a fuller report.

The curve mentioned immediately after is the curve which would have for abscissa the induction (as in Rowland's previous curves), and for ordinate the permeability of the magnetic circuit, defined as I have defined it in my Royal Society paper. These curves would bear a reciprocal relation to curves of resistance such as I have drawn (*Phil. Mag.*, June, 1884, p. 334), the one set being always concave where the other is convex. The flatness in the middle of the curves described

* In the summary of formulæ at the end of the original paper $\frac{r}{l}$ is inadvertently printed for $\frac{l}{r}$. In the body of the paper the formula is rightly given.

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by Rowland is recognised at once in the curves just referred to. No doubt the other curves, with which Rowland compared those he was describing, were the original curves of permeability of his rings.

However, to understand Rowland's intentions completely, we must wait for a fuller report.—Yours, &c.,

R. H. M. BOSANQUET.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I note with considerable surprise that Dr. Stone considers the human body exceptional in its behaviour as a conductor. If he means that it has the property of altering its resistance merely in obedience to the E.M.F. of the testing current, without having undergone any previous physical change, I think he will hardly find confirmation of his views in the case he has quoted. If one thing is shown more than another in Mr. Mance's paper, and in the whole of the discussion—even in the very title of the paper itself—it is that the condition of the conductor at the fault is constantly changing, and the very object of the test is to eliminate the value of the erroneous resistance or E.M.F. caused by the action, principally electrolytic, which is going on, ever-varying, at the fault. I would refer Dr. Stone to Mr. Latimer Clark's beautiful experiment in the wine glass, which is described on page 351 of the *Journal* of the Society of Telegraph Engineers and Electricians, which bears so closely on the subject of Mr. Mance's paper, and also, I venture to think, on the matter under discussion.

I should like to ask Dr. Stone if he can adduce any reason beyond the bare fact that his measurements differ for believing that the human body possesses the property I have named, and also if he does not find a similar result attend measurements made with a comparatively weak current, if the current be allowed to flow for some time, provided the current strength remain constant.

From observations that I have made on my own person I have formed the opinion that the resistance of the body, or at least some parts it, falls with a continued application of a direct current.

The apparent alteration of resistance, in obedience to varying E.M.F., more especially the falling of resistance as the E.M.F. increases, and the lowering of the resistance on the continued application of an E.M.F., are phenomena which are by no means unfrequent in the everyday work of the electrical engineer. As a striking example, I may mention the case of two points in an electric light circuit closely contiguous, between which a rather high difference of potential exists. If the material which is used as an insulator between the two points can be changed physically by the infinitesimal current which passes, the insulation resistance in many cases falls, and you have a powerful current passing where you do not want it, putting you to serious inconvenience.

In reply to Mr. Sennett, I may say that I am constantly, as far as time and opportunity will allow, making experiments and observations bearing upon this very important subject. May I ask that he and others will follow my example? By so doing I feel sure that we should soon collect a vast amount of very valuable information. I am surprised that Mr. Sennett, who has evidently studied physiology, is unable to follow my remarks *re* opposing E.M.F. My reasoning is simply as follows:—We have in every part of the body numerous vessels containing fluids in rapid motion. Taking only the blood vessels, which appear to conduct the best on account of the blood which they contain, we have in every part of the body, side by side, an artery and a vein. Supposing that an electric current be passing through a certain portion of the body in a given direction, it will divide between the artery and vein, passing in the same direction in each. I am here reasoning on the hypothesis that the current passes only in one direction; in each it will create a magnetic whirl around it—or, in other words, a magnetic field. But each conductor —the fluid blood—is in motion in the field created by the other, and, further, they are moving in opposite directions. Therefore I say that a minute E.M.F. will be generated wherever a current passses through a portion of the body containing such vessels. I have no doubt that I shall be told that the E.M.F. must be so small as to be negligible. But is it? Remembering how small are the figures we are dealing with all through, it certainly appears to me by no means so.

Take again the case of the fault in the submarine cable. How small is the surface exposed in the most troublesome faults, and how minute are the currents generated in most cases. I think it will be found that the E.M.F. generated in the body, as I have suggested, and also possibly by the secondary products of electrolysis, bear quite as large a proportion to the currents circulating there as do the polarisation currents, E.M.F., or resistance, whichever form it may take to the ordinary currents used in working and testing the cable.

Now, as to the models and diagrams. I do not think I have suggested anywhere that the resistance of wood models should be measured with a view to obtaining therefrom the resistances of the various parts of the human body; but I do think that the collective ability that has been shown in obtaining such a mastery of the different organs, even to their minutest vessels, &c., should not sit down and say it is impossible to follow the current after it enters the body, because we do not know the proportion that will be taken by the different organs—I use the term in its widest sense—through which it passes. I ask again, Why is it impossible? If we had a bundle of wires covered with cotton, or silk, or other insulating substance, or, what would perhaps form a nearer parallel, a bundle of wires drawn from various metals, would it then be impossible to calculate what proportion of current passed through each? And what are the blood vessels, the blood, the nerves, &c., but conductors, all of high specific resistance, but all varying?

And then as to the use of such plans. Do we not every day hear of some one who has contracted a disease with a name unintelligible to lay understandings, and then we learn that it is something that has happened to some internal membrane or some delicate vessel deeply seated within the body? May it not be that some organ, some membrane, or some vessel, either in health or disease, can withstand a certain current, but if it receives a larger current, though the total current strength itself may be ridiculously small, yet the extra strain caused by the excessive strength of that proportion of the current which passes through that organ may cause a serious or even a vital injury?

I understood Dr. Stone to say "No! it may not!" If I may be allowed, without wearying him too much, or asking him to write a treatise on physiology for my especial benefit, I would ask, Why not?

With regard to Mr. Sennett's remarks as to the action of continuous currents and alternating currents, so far as I understand them, we are at one on the matter, as I think he would find on a perusal of my letter. If Mr. Sennett can produce figures that shall be an accurate measure of the absolute resistance of the body, I will acknowledge myself in error; until he does so I shall maintain that the valuable time spent in measuring from hand to hand and from foot to foot under conditions that could hardly occur in practice might have been more profitably employed.

I trust that it will not be taken that any discourtesy is meant to Dr. Stone or Mr. Sennett by this remark; it is merely the expression of an opinion.

I consider Mr. Sennett's proposal for the slaughtering of animals a very valuable one, and that its adoption, or that of some similar arrangement, would confer a great benefit on those who at present are what I can only term the victims of a brutalising custom. Has it not been shown, however, that the quality of the meat would be deteriorated?

In conclusion, I think that the suggestion of a committee to go into the whole question is also a very valuable one, and I trust that Mr. Sennett will not confine himself in his paper merely to the record of accidents. I would suggest also that a circular addressed to our American friends would be productive of most valuable results, they having so much more experience with high tension currents than we have.—Yours, &c.,

SYDNEY F. WALKER.

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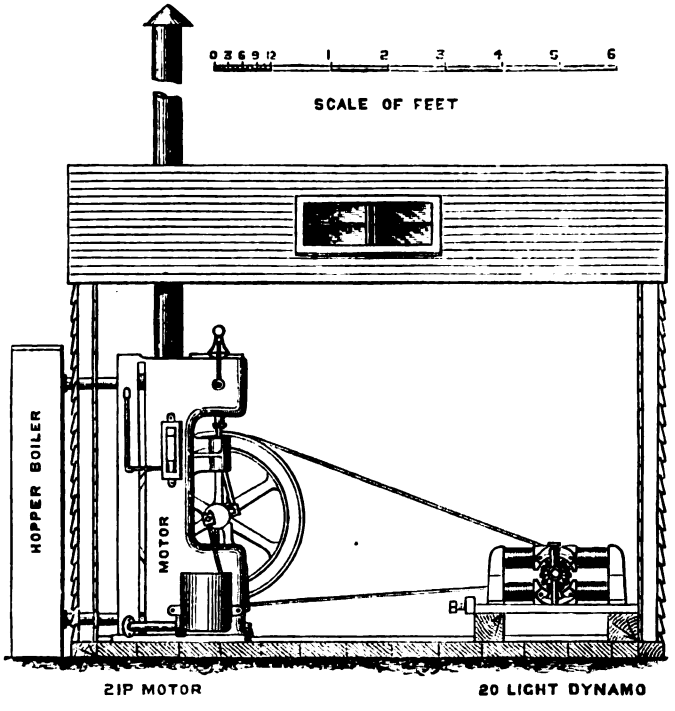
THE DAVEY MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "A Young Engineer" (telegraphic, I presume) in last week's *Electrician* says:—"The Davey motor has been illustrated in nearly all the engineering papers." Will he kindly name a few? I have not seen a description of it in *The Electrician*. If "A Y. E." has read the description in nearly all the engineering papers, why is it, instead of rounding on me, he did not enlighten "A Subscriber," "D.," and myself? Quoting from his letter, he writes:—"Mr. Davey states that he adopts ¼ lead pipe, and I do not gather from his letter that the pipe is used to convey water," Precisely; neither do I. Mr. Davey wites in reply to "D.":—"In my case the *pipes* (not pipe) run up the walls and along the cornice, where they are out of sight (but not lost to memory dear if he uses steam); it matters not how many twists and turns and ups and downs the pipes (not pipe) make."

Unless Mr. Davey has introduced a new element, steam will not travel through a ¼ lead pipe any considerable distance without condensing, a fact "A Y. E." ought to have known. That disposes of the up and down theory of Mr. Davey. Water will not travel unless flow and return pipes are used, and a tank be fixed in the upper part of the house; and my word for it, if "A Y. E." or any one else depended on a ¼ pipe warming his house in mid-winter on that plan he would be precious cold. In Perkins' patent system a ⅞ bore hydraulic iron pipe is used, and the temperature of the water raised to above 300° F., and it circulates under great pressure. Now, a ¼ lead gas pipe would hardly do for this system. Will Mr. Davey furnish our editor with a rough sketch of his motor, and a plan showing the ¼ lead gas pipes in use. I name Mr. Davey, as I feel certain "A Y. E." can have but an elementary knowledge of the laws of hydrostatics or steam. In conclusion, let me inform "A Y. E." that as a rule I do not rashly cut recesses in my walls to bury my pipes without due consideration, and he may rest assured that a 1¼ pipe would not have been used if a ¼ gas tube would have done the work. Apologising for intruding so much on your valuable space.—Yours, &c., PHŒNIX.

[Mr. Davey has sent us drawings of his machine room, from which the following illustration has been prepared. The coke



used is shot into the hopper shown. The motor is of 2 horse-power, driving a 20-light dynamo. We might state, in reply to "Phœnix," that the motor has been twice illustrated in the *Engineer*, but it was not till a day or two before this correspondence commenced that we knew the motor was used for electric light purposes. An illustrated description of the motor shall be given as soon as the pressure on our space from companies' meetings allows us room.]

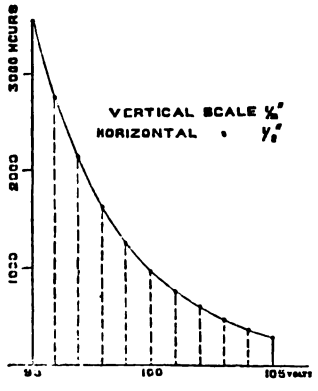
INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: About eight months ago I pointed out to one of your contemporaries many singular agreements between the duration of incandescent lamps—as stated in a German technical journal—and the ordinates of a hyperbolic curve; so it has just occurred to me to look into the particulars given on page 246 of a recent number of *The Electrician*.

It is impossible that the average life of Edison lamps, when subjected to "a very extended series of tests," will be greater than we find it in practice; but it is remarkable, to say the least of it, that whenever a careful record is published the average life of lamps burning at their normal candle-power is always said to be 1,000 hours exactly.

Further, it is in the highest degree improbable that when plotting out the results of an experiment we should get such extreme regularity as I have observed in the figures supplied by Mr. G. Foussat, and I cannot help thinking that your correspondent has been deceived.



I enclose a simple diagram to make my meaning clear.—Yours, &c., WM. H. MASSEY.

Twyford, Berks, 10th February, 1885.

LOSS OF POTENTIAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be much obliged if you, or any of your correspondents, could tell me of a practical text-book which deals with the above subject. Is there any book published in the same style as "Day's Electric Light Arithmetic" which takes up this important subject? If there is not, I would suggest that one or more papers on the above in the pages of *The Electrician* would be of immense service to others besides myself.—Yours, &c., E. M. F.

[Professor Forbes is, in the Cantor Lectures now being given before the Society of Arts, dealing somewhat fully with this question. These lectures will be given fully, and not in abstract, in our pages.—ED. *E.*]

ELECTRICITY DEVELOPED BY CONTACT OF SIMILAR METALS.—PRELIMINARY ANNOUNCEMENT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In performing some experiments on the conductivity of the human body I observed the following phenomena, and as I can find no reference to the subject in any book on electricity I claim priority of discovery.

I placed a copper wire in my mouth and held another in my hand; the free ends were connected to a sensitive galvanometer. On completing the circuit a deflection took place. I tried this experiment several times and used different sized wires, and always with the same result. The mouth appeared

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to be positive, and the hand or other parts of body negative, except in the case of the nose, for on placing one wire up the nostril and holding the other in the mouth I obtained a deflection, showing the nose to be positive. I at first thought these effects were due to a current in the body, but found on placing the wires in dilute saline solutions, and even in *distilled water*, the same result took place.

I next employed wires and plates of copper, silver, iron, and zinc. Deflections were always produced on placing one in the mouth and the other at any part of the body ; also on moistening the plates with distilled water, and putting them in contact.

From the above facts it can be seen what two wires or plates of the same metal can produce. In all cases both wires were cut from the same coil and the plates from the same sheet of metal. Nos. 16·20, 30·36 B.W.G. wire was used. The galvanometer was a reflecting one of my own construction, and wound with 36 silk-covered wire ; resistance about 200 ohms.

Trusting you will pardon me for occupying your valuable space with what may be "stale news."—Yours, &c.,

W. A. RUDGE.

Holyrood-place, Plymouth.

[We do not think these experiments are new to the majority of our readers, nor must we expect to find everything that has been observed recorded in books.—ED. *E.*].

THE ANGLO-AMERICAN TELEGRAPH COMPANY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : From the notice of the voting at the adjourned meeting of the Anglo-American Telegraph Company published in the daily papers on Monday last, it would appear as if all the shareholders had been invited to give their opinion upon the question brought forward at the meeting whether or not Mr. Cyrus W. Field should be requested to resign. Such, however, was not the case, no attempt having been made by me to obtain proxies from absent shareholders; but the question was unmistakably answered in the affirmative by the majority of the shareholders present at the meeting. The directors, as usual, demanded a poll, in order to record the proxy votes of country shareholders, who had not heard the arguments and discussion, and, consequently, were not in a position to form an opinion. If they had been present probably not one of those votes would have been recorded against the resolution.

It is time that shareholders should take some interest in the management of their affairs, but from long habit they meekly sign the proxy form sent to them by their directors, thus putting a complete check upon any efforts which more active shareholders may think it advisable to take for the improvement of their property. In the case of the Anglo-American Company, I took the precaution to give notice to the directors of my intention to move a resolution requesting the resignation of a particular member of the Board, and asking that a copy of the resolution should be sent to each shareholder with the report, but this very fair proposal was declined on the ground that it was "not in the interest of the company." The shareholders present, however, after hearing the discussion, thought otherwise. It is quite evident that meetings of shareholders are becoming unnecessary, as the opinion of those who take the trouble to attend them is systematically ignored. Much valuable time, and, no doubt, inconvenience to the directors would be saved by the chairman of the Anglo-American Telegraph and other companies printing and circulating an address, together with the intimation that the report and accounts had been unanimously adopted by the directors at a special Board meeting called for that purpose, and consequently a meeting of shareholders was not requisite or desirable.

With regard to the number recorded as having voted at the poll at the meeting last week, most of the shareholders had left the room, or were quite satisfied with the part they had taken in the moral demonstration against the action of the directors, and they felt that it was hopeless to overcome the mass of proxies behind which the directors had so ostentatiously entrenched themselves.—Yours, &c.,

16, Tokenhouse-yard, E.C. WILLIAM ABBOTT.

STRANGE, IF TRUE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : Under the above heading you publish in your issue of the 31st ult. an account of the wonderful curative effects produced by wooden "magnets." Instances might be multiplied where imagination and faith in the means used have resulted in the complete cure of all kinds of complaints, particularly nervous diseases; whilst the more mysterious the agency in the eyes of the patient the greater will be the chance of successfully evoking these two most powerful therapeutic agents. Some years ago, Mr. Snape, surgeon dentist, of Chester, having announced his ability to extract teeth painlessly by the aid of electricity, my father, Mr. J. Rogers Bate, fitted up a similar apparatus, consisting of an induction coil, with water regulator in the primary, one end of the secondary attached to the forceps, the other in contact with a metal plate on the arm of the operating chair, so placed as to be grasped by the patient, whilst a simple circuit closer located on the floor enabled the operator to control the flow of current by the pressure of his foot. The most feeble battery power was, as may be supposed, quite sufficient, and under the benign influence of the new local anæsthetic painless extractions became the rule, although, as may well be imagined, the exceptions usually proved excessively painful operations. It was necessary for the coil to be placed so that the patient could hear the slight hum of the contact breaker, or the percentage of failures rapidly rose, whilst so long as the sound was audible it seemed quite immaterial whether the secondary circuit was opened or closed. Nervous people, who believed the operation was going to be painless, usually found it so ; whilst unbelievers either experienced no relief at all, or, as stated above, their sufferings were much intensified.

I remember reading, if I am not mistaken in an old volume of Guy's Hospital *Reports*, of most miraculous cures effected by an electrical arrangement, which went, I believe, by the name of "Perkins' tractors," and were continued when silk cord and tinfoil-covered wood were substituted for the conductors and electrodes of "Perkins'" apparatus.

If I am correct as to the source of my information, Dr. Stone would doubtless be able to furnish some instructive remarks on the subject.—Yours, &c., DOUGLAS C. BATE.

1, Wellington-villas, East Dulwich, Feb. 2, 1885.

Hammond Company Electrical Engineering College.

On Tuesday evening, February 3rd, the President of the Hammond Company Electrical Engineering College entertained at dinner the staff and students of the college at the First Avenue Hotel.

After the usual loyal toasts, Mr. F. C. PHILLIPS proposed "Success to the College."

Mr. HAMMOND, in responding, pointed out that the college was first started to supply a want which was felt throughout the electrical world. There were no skilled electricians combining practice with theory, and after having experienced many disappointments, he arrived at a determination of which the college was the outcome. He pointed out that the study of electricity was in every way a desirable one. It not only gave the intellectual faculties full play, but afforded stimulus to renewed exertion by bringing its votaries face to face with those absolute truths which could not but elevate the human mind.

Mr. ROBERT VENNER, in proposing "The Staff of the College, and the Principal, Mr. H. E. Harrison," referred in high terms to the members of the staff, and testified to the great advantages that he and the other students had derived from the special method of training adopted in the institution.

Mr. HARRISON, who rose to reply amid loud and prolonged cheering, said that although immediately after the formation of the college the electric lighting industry reached its lowest stage of depression, yet all the original pupils had persevered in the profession they had adopted, and it was gratifying to learn that of the Hammond Company's apprentices who had completed their time last September almost all had obtained good appointments.

The toast of "The Hammond Company" was given by Mr. HOFFMAN, and replied to by Sir CHARLES L. YOUNG, Bart., the Chairman, who, after expressing the great pleasure he felt in sitting at the right hand of the President that evening, said that in many of the problems which came before him in his official capacity as Chairman of the Hammond Company he had been helped by the knowledge which his son had acquired at the Hammond College. He felt certain that the City electric lighting contract —the deposit upon which would be paid during the following week— would give employment to even more students than they had at present in the college.

A few songs and recitations brought the evening to a close.

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COMPANIES' MEETINGS & REPORTS.

Anglo-American Telegraph Company (Limited).

The ordinary general half-yearly meeting of the proprietors of this Company was held on the 6th inst. at the City Terminus Hotel, Cannon-street, under the presidency of the Right Hon. Viscount Monck.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting and signed by the Chairman as correct.

The CHAIRMAN: Gentlemen, it now becomes my duty to move the following resolution:—"That the report of the Directors and accompanying statement of accounts to the 31st December, 1884, submitted to this meeting be and the same are hereby received and adopted, and that the following dividends, less income tax, he now declared—that is to say, first, a balance dividend of 17s. 6d. per cent. upon the ordinary consolidated stock for the year ended 31st December, 1884, making with previous payments 3½ per cent. for that stock for the year 1884; secondly, a balance dividend of £1 10s. per cent. upon the preferred stock for the year ended 31st December, 1884, making with previous payments 6 per cent. upon that stock for the year 1884; third, a first and final dividend of 5s. per cent. upon the deferred stock for the year ended 31st December, 1884." Gentlemen, in moving this resolution I shall, in the first place, congratulate you on one important fact, namely, that your main cables between Europe and America are all in good condition. That fact is an important one at all times, but it is especially so on the present occasion, because at this moment there are four cables of the combined cable companies which are not working, so that the whole work of the Atlantic, as far as our combination is concerned, is done by our cables. I merely mention that fact, which you must bear in mind in considering all the different subjects that will come before you to-day. I will now say a few words as to the figures in the accounts. The revenue account of the half year ended last December shows that the expenses when compared with those of the corresponding period of 1883 have increased £2,493. But in that expenditure of 1884 is included a sum for the repair of the buildings at Heart's Content. The net increase in the expenses of 1884 is £2,493, as I have said, but the expenses attributable to this building are £2,846, so you see if we had not had this extraordinary and inevitable item of expenditure on this building, our outlay for the half year would have been less than for the corresponding period of 1883. I may mention, as a proof of the desire of your Board to keep the expenditure at as low a figure as possible, that the salaries at home and abroad, taken together, show this half year a net decrease of £538, as compared with the corresponding half of a year ago. The revenue for the half year, I am sorry to say, is £12,136 less than that of the corresponding period of 1883. That I apprehend is due principally to the depression of trade which still continues on both sides of the Atlantic, for although our tariff was reduced on the 24th December, 1884, to 1s. 8d. from 2s. a word by the action of the Mackay-Bennett cables, it is not conceivable that the reduction just then would have had any appreciable effect on the half year's revenue; because in the first instance it was only one week in operation, and in the next instance it was in a week not very productive, as it included the Christmas holidays. As I have told you, your cables are working well and in good condition, as far as the main cables are concerned. There are some tributary cables on the other side which are out of order, but that does not interfere with the transmission of messages, as we have the advantage of the Direct and other cables to supply their places. The real question we have before us to-day is the importance of this new competition. I regret to say that, as far as we are concerned, the circumstances to which I have alluded cause this competition to have begun at a very unfortunate period for us. Our competitors, the proprietors of the Mackay-Bennett cables, will no doubt be guided in their future course in a great measure by the result of the operations they are now conducting; and it must be plain to all of you that, four of the competing cables being out of order, the Mackay-Bennett cables must take a much larger proportion of the traffic across the Atlantic than they would do if they had our eight cables to compete with instead of only four. In fact, as I have said before, given a certain number of cables working with equal efficiency, each will take its due proportion of the general traffic. You will naturally ask the Board what we mean to do under the circumstances, and I am afraid at this moment I cannot give you a very satisfactory answer to that question. It is obvious that there is very little use approaching the Mackay-Bennett people with a view to any arrangement or compromise till they have ascertained for themselves and by themselves, and by the operation of their traffic, what their future will probably be. As to any other course, I do not think it would be wise for me to indicate it at present. Your Board, taking the best advice they can get, and watching anxiously the conditions under which the traffic is being conducted, and the development of circumstances, will take that course which they believe to be best for your interests. I do not like to indulge in prophecy; but it strikes me that the ultimate outcome of all these proceedings will not be as favourable to the telegraphing public as they imagine a large number of cables and consequent competition will be. There is an old adage that where combination is possible competition is not very likely to go on at a loss to all parties concerned; and I would fain hope that by some means or other we shall find a way of all making a living out of the Atlantic traffic. But at present the time has not arrived when I believe any effective step could be taken for that purpose. I must ask you, as I have before done, and never without success, to place confidence in your Board, and to entrust them with your interests, believing, as I can assure you is the fact, that they are as anxious to maintain your interests and to make a good income for you as any one in the room can be. There is another burning question which we have had up before now. It was discussed at the last meeting, viz., the amount to be laid aside to the renewal fund. I went so largely into that question at the last meeting that I think it is scarcely necessary for me to weary you by renewing my arguments on the present occasion. But I think the state of circumstances to which I alluded in the early part of my observations, viz., that four cables are at this moment disabled in the Atlantic, ought to exercise considerable influence on the decision you come to on that point. Those cables might just as well have been our four cables as the cables of the Direct, Jay-Gould, and Pouyer-Quertier companies. In point of fact two of the cables at all events that are broken are much newer than any of ours, and therefore it affords a strong example of the insecurity of cable property, and the absolute necessity that exists, if you mean to carry on your work, of having the means at once of renewing or repairing a cable when it breaks down. There is another view of this question, and, though I put it forward at the last meeting, I see so many more present to-day than there were on that occasion, that I may allude to it again—that is, the responsibility which your Board would incur if they paid dividends to the neglect of making provision for keeping your enterprise going on as a going concern. I believe it is very questionable whether—if it is not an absolutely certain rule of law—if Directors, against their own judgment, acting from any pressure from without, pay dividinds which they would not be entitled to pay, which they would not be authorised to pay if they were acting so as to keep the concern going, would not be personally liable to any gentleman who liked to sue them. [A Voice: "Nonsense."] Well, it may be nonsense, but still I believe it may be very good law. Sometimes law appears to be nonsense to people who do not understand it. Therefore, though a gentleman calls out nonsense, I do not think my colleagues are likely, on such an opinion, to run the risk of rendering themselves liable to considerable legal obligations. Your Board have given this subject the fullest consideration, and have arrived at the conclusion that your renewal and reserve fund is not sufficiently large to enable them conscientiously to say that they could deduct anything from the sum annually laid by for the purpose of paying additional dividends. That is the conclusion they have arrived at after having given to it the best consideration which their intelligence is capable of, and having come to that conclusion, we should not be acting honestly by you or our own obligations if we did not announce that decision and adhere to it. I do not know that there is anything else particular that I have to apply myself to at present. We mean, as I have said, to observe this competition, to watch the progress of it, and to mark the development of events, and to take such a course as we think to the best of our judgment will be satisfactory for your interests and the protection of your enterprise. I have nothing more to say except to propose the resolution which I have read.

The Most Hon. the Marquis of TWEEDDALE seconded the motion.

Mr. THOS. SMITH (York) moved, as an amendment, "That whereas the Directors have failed to carry out the resolution and wishes of a large majority of the shareholders at the meeting held in February, 1884, the report now before us, so far as regards paragraphs 3 and 4, be not received; and, first, that £50,000 instead of £75,000 be carried to the renewal account, making the net profit for the past half year £165,426, which with the payment of the interim dividend on the 1st November (which took £52,500), will leave a net balance to the revenue account of £112,926; second, that a dividend be now declared of £1 5s. per cent. on the ordinary stock, making the total amount for the year 3½ per cent.; £1 10s. on the preferred stock, making the usual 6 per cent.; and a dividend of £1 on the deferred stock, to be paid less income tax, leaving a balance of £25,426 to be carried forward, as against £1,676 which the Directors propose." In view of the competition to which allusion had been made, he thought the balance which the Directors proposed to carry forward was very small. The Directors admitted an impending loss of £170,000 of traffic, and they would find the £25,000, which he proposed should be carried forward, of great use in equalising the dividend next year.

Mr. PRUST: That is on the whole of the cables.

Mr. SMITH agreed that that was so. The amendment he had moved was the same as that which he proposed last February, which he was induced by Lord Tweeddale, who then presided, to withdraw in the full assurance and promise of the noble marquis that, if he did so and put it in another shape, and if the majority were in favour of it, it should be carried out. As he had no doubt at that time that Lord Tweeddale would keep his word, he (Mr. Smith) withdrew his amendment and put it as a resolution, which was carried by a large majority. But the shareholders knew the result. Since then they had had another Pharoah to reign over them, who had done quite the opposite of what the noble marquis promised. He maintained that it was within the truth when he said that Lord Tweeddale promised that if the resolution were carried the Directors would carry it out.

The CHAIRMAN: Oh, no.

Mr. SMITH: I beg your pardon; you were not there. He then went on to say that if the Directors' report were adopted as it stood the amount carried to renewal fund would not be, as was stated, £70,000, but with the interest on the investments forming the renewal fund the amount now transferred to that fund would be altogether £85,854, which he considered was not fair to the shareholders. The amount which he had mentioned was only £29,000 less than what was being distributed in dividends. At first the proposal was that 10 per cent. should be taken from the revenue and added to this fund. It was afterwards increased to £100,000 a year, and then to £150,000, and now it was £180,000. He maintained that the Directors' interests, on account of their small holdings and the amount of the fees which they received, were not the same as those of the shareholders. And he also maintained that the Directors did not care whether there was a dividend or not. Since 1880 they had paid the Telegraph Construction and Maintenance Company £600,000, and they were largely interested in that company.

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A SHAREHOLDER observed that Mr. Smith was making a statement which he (the speaker) knew was not a fact. What Lord Tweeddale said was that the time had arrived when the deferred shareholders ought to be considered.

Mr. PRUST: I wish that time had arrived.

Mr. SMITH trusted that the Directors would see the reasonable nature of his amendment and frankly accept it. He was representing interests at York of £100,000 stock. If his amendment were agreed to, the renewal fund would stand at £700,000. If they went to the Telegraph Construction and Maintenance Company for a new cable without competition there was no doubt that that company would charge them £600,000, but if they offered it to competition he believed they would get it 50 per cent. less.

Mr. BAKER seconded the amendment.

The CHAIRMAN: The amendment is such that I cannot put it to the meeting consistently with the Articles of Association under which we meet. His lordship referred to Clause 164, and said: It is evident by this Article that the duty of setting by a reserve fund and the amount of that fund devolve entirely on the Directors. By Article 165 it is provided that no larger dividend shall be declared than is recommended by the Directors. It is therefore perfectly plain that this amendment cannot be put unless those two Articles are first of all repealed. I must decline, acting under these two Articles, to put the amendment to the meeting.

Mr. SMITH: Then I beg to move that the report be not accepted.

The CHAIRMAN: That is a negative.

Mr. PRUST said he had sent in to the Secretary a notice of motion of a proposed resolution as follows:—"That no more capital should be taken from the renewal fund for the purpose of laying new cables, unless sanctioned by the shareholders in general meeting assembled." He had been a shareholder for a great many years, and at a considerable loss. He was a deferred holder, and his stock cost him about 36, whereas it was now 7 or 8. He quite agreed with Mr. Weaver that it was absolutely necessary that the Company should have a large sum set aside as a reserve fund to protect them, but he thought the time had arrived when they had attained what they wanted. They were now actually the holders of £726,000, the hard earnings of the ordinary and deferred shareholders, because it had been taken from them. It had not come out of the pockets of the preferred shareholders at all. Those gentlemen had their dividends regularly. The interest arising from this £726,000 was about £20,000 or £25,000 a year, and from year to year £20,000 was about the cost of repairs. Four years ago his stock was 32—it was now 7, the reason for that state of things being that he had gone without any interest during those years. He did not wish to take anything from the reserve fund as it now was, but to leave it intact, and to add the interest which it earned to it, and he did not object to their taking in addition £25,000 a year from the revenue. But after that he maintained that enough had been taken out of the pockets of the deferred shareholders. In all railway matters a general meeting had to be consulted before the Directors did anything in the way of spending money; but that was not the case with this Company, and his object was that they should not spend more of this renewal fund unless they got the shareholders' sanction.

Mr. BLUMENTHAL, in seconding the resolution, said that the Articles of Association were one-sided only. It did not necessarily follow, however, that those Articles were right, for common sense often took the place of Articles of Association. He was connected with many companies, and he could show numerous flaws in Articles of Association, which in many cases were made to suit gentlemen sitting on one side of the table. The Board were the shareholders' servants; but, on the other hand, the shareholders were the most obedient servants of the Board. He generally liked a little pleasure for his punishment, and his punishment had been having bought stock in the Company at the top price. The pleasure he would like would be a little dividend. But if the Directors were going on as they seemed to be his hair would become greyer than it was before he got that pleasure, and indeed he would have no hair at all.

Mr. SMITH, of York, referred to Article 53, and said he thought he was within bounds with his amendment.

The SOLICITOR (Mr. Burt): You must read them together.

Mr. SMITH: It may suit you to say that, but I take it as it stands here.

Mr. JACKSON asked what prospects there were of the broken cables being repaired. He thought the present time was very inopportune to urge with insistence on the necessity of discontinuing additions to the renewal fund which the Company now happily possessed—inopportune under the circumstances. But the circumstances, after all, were transitory, for in the course of a month he hoped they would see that at least three of the four broken cables were working again, and the position would then be that not one half of the cables would be employed, and the Board knew better than he did that the renewal fund did not require to be increased by £170,000 a year. The Board in their conduct towards the shareholders seemed to him to pursue a very arbitrary policy, in effect—"we know the business better than you do." He could not agree, as had been suggested, that the Directors would sacrifice the interests of the Company to those of the Telegraph Construction and Maintenance Company, although they were directors of it. On the last occasion he asked how much renewal fund would be required, whether one million would be enough, but the Directors absolutely refused to give the slightest information on the point. He thought the time had arrived when the Board must say something to the shareholders on this matter, in order to avoid dissension and division. The shareholders did not want legal pellets flung at their heads, but conduct which was reasonable.

Mr. CHESTER thought the resolution proposed by Mr. Prust was most important. The Board had now £720,000 in hand, which had been kept time after time from the pockets of the ordinary and deferred shares, and they were in such a position now that they could come to the next meeting and say that a new cable had been laid by the Telegraph Construction and Maintenance Company, and that £700,000 or more of the renewal fund had been paid for that cable. It was true that the Articles of Association gave the Directors certain distinct powers, but he thought that, morally and equitably, such powers were wrong. Could they not say that, although they had this power, they did not wish to act on it; and could they not consent to the resolution of Mr. Prust?

Mr. WM. ABBOTT did not think any one could object to the resolution proposed by Mr. Prust, and he thought the Board would exercise a wise policy if they accepted it. He had now attended meetings of the Company year after year, but every time they came there and made any suggestion which they believed was in their own interests the Directors said, "Oh, we know all about it, and it must be left to the Board." He thought the opinion of a man like Mr. Jackson deserved to have weight with the Board. If it did not, why did not the Directors call such a meeting as that they were now engaged at after the Board meeting, and dispense altogether with calling a meeting of the shareholders? He maintained that the time had now arrived when something must be done for the shareholders—and there were various ways of doing it without interfering with the prerogatives of the Directors. He always at their meetings saw a formidable array of proxies, and Mr. Burt was also present, who flew at the Articles of Association. The shareholders, however, after all, must have rights in the Company in which they had embarked their capital. The Directors were in such a position that they were ignorant of the distress caused to many by receiving very small or no dividends. Looking at the capital of the Company—the whole amount was seven millions, and it was selling in the market for £2,200,000. Deducting the reserve fund of £720,000, there were, according to the market, £1,450,000, representing the value of their four cables, their goodwill, and all their rights. He thought the Directors could accept Mr. Prust's resolution, and that they might promise the shareholders to take into consideration a scheme which might be proposed for the reconstruction of the capital of the Company, and the expunging of some unsatisfactory clauses from the Articles of Association which year after year were the bone of contention between the Directors and the shareholders. He thought if the Company were reconstructed, and the capital divided half and half into debentures and ordinary stock, limiting the addition to the reserve fund to £100,000, instead of £150,000 a year, life would be put into the concern, and a certain portion of the debentures could be drawn every year. If that were done, instead of seeing their stock a drug in the market, they would have a certain amount of the capital as it were drawn every year and cancelled, thus increasing the reversionary value of the ordinary stock, which would give it a considerably advanced price in the market. He believed this would be satisfactory to all parties, and it could be done at very little cost. If it were necessary to fight the new competition, they would be in a better position to fight with a small capital than with a large. As to the reserve fund, he quite agreed with the resolution proposed. It would be madness to allow any more cables, for there were too many already. He must say, however, that he thought it a very fortunate circumstance for the shareholders that their cables were laid by the Telegraph Construction and Maintenance Company, for at the present moment those were the only cables working.

Some discussion took place between Mr. Abbott and the Chairman at this point, concerning a resolution which Mr. Abbott expressed his intention of proposing, and the Chairman said that it would only be in order to hear this motion after the ordinary business was completed.

Mr. ABBOTT finally agreed to postpone his motion.

Mr. SEELEY inquired what was the amount of interest yielded by the investments of the renewal fund in 1884, and the number of *employés* who took £25,000 paid in wages. He thought that in existing circumstances that expenditure should be cut down to the lowest limits.

The Managing Director (Mr. WEAVER), in reply to Mr. Chester, said that the Company now transmitted the whole of the traffic, but they did not get the whole of the receipts. They got a certain proportion, as stated by the agreement between the associated companies. This Company had nothing to do with the repairing of the cables of other companies.

Mr. TROWER suggested, in view of the loss of £170,000 a year by the competition to which reference had been made, whether it was not possible to have an amalgamation between this Company and three other companies that were in the union, so that some portion of this £170,000 might be recovered in that manner.

Mr. JOHN NEWTON said that the interest gained by the renewal fund was added to the renewal fund, but was that in the Articles of Association? If not, he should contend that this interest was part of the reserve and ought to go to the revenue account. He contended that it would be a very small matter to reduce the capital from seven to five millions, in which case it would not be legally necessary to put aside £170,000 to reserve fund.

The MANAGING DIRECTOR pointed out that the amount of capital had nothing to do with the maintaining of the cables.

Mr. NEWTON said that he had spoken of the subject as a matter of law. He maintained that the Articles of Association ought not to be constantly thrown in the faces of the shareholders.

Mr. HUMPHREYS contended that the assessment for the renewal fund ought to come out of the pockets of all the shareholders, whereas £2,600,000 of the capital paid nothing into the reserve fund.

The Marquis of TWEEDDALE: I hope you will allow me to make a personal explanation. I should not have occupied the attention of the meeting had not Mr. Smith repeated here the statement which he made at the last meeting. He stated on the last occasion, and he has repeated it to-day, that this time last year, when I presided over the meeting, I made a promise which was not kept, and that owing to that promise he withdrew his amendment. That statement is absolutely unfounded, and I would remind you of what occurred. He then quoted from the shorthand writer's notes the remarks which he had made in proof of his statement that Mr. Smith's assertion was unfounded; and added that, with

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regard to the withdrawal of the amendment, he had pointed out that Mr. Smith's amendment was irregular and could not be put.

Mr. SMITH: Our amendments always are irregular.

Mr. BAKER said that though the amendment referred to might have been out of order it was carried by a large majority in the room, but the Directors had not the courtesy even to listen to what was said, and put the same amount to the renewal fund as they did on the present occasion. He repeated emphatically that the recommendation was proposed in that room and carried by a large majority that £100,000, instead of £150,000, a year should be put to the renewal fund; and with regard to the matter having to be dealt with at the next meeting, had the Directors not held the proxies of the Globe Company and the Submarine Trust he believed the shareholders would have beaten the Directors on their own ground.

The CHAIRMAN: It now devolves upon me to make the best answer I can to the different observations addressed to the meeting. Permit me to say, in the first instance, that I am inclined to make every allowance for the feelings of shareholders, particularly deferred shareholders, who come here and find that there is little or no dividend. I will not at all refer to the angry—I had almost said offensive—expressions used to the Board. I shall only make one observation on that point. It has been almost explicitly asserted that your Board sacrificed the interests of this Company to that of the Telegraph Construction and Maintenance Company, and that assertion was based on the statement that we, the Directors of this Company, were largely interested in the Telegraph Construction and Maintenance Company. It is right that you should know the exact facts on that point. The exact fact is this, that not a single Director, as far as I know—and I believe I do know—is interested, directly or indirectly, in the Telegraph Construction and Maintenance Company except one, and that is Sir Daniel Gooch. And what is Sir Daniel Gooch's holding in this Company? His holding—and I believe he has never parted with a share; he is one of the founders of the Company; he has, through good and evil report, stuck to this Company, and is now the holder of £35,000 of your stock. Let me, in the next place, say that the question has been raised by Mr. Newton whether the interest accruing from the reserve fund should be added annually to the reserve fund or treated as ordinary income and distributed among the shareholders. That, I think, is a perfectly reasonable question to discuss. *Primâ facie*, I think the proceeds of the reserve fund ought to belong to the reserve fund; but whether in the circumstances it might not be well to divert it to reserve account is a question we are called upon to consider, and I shall take care that it shall be considered. Mr. Smith has proposed a resolution which I understand is withdrawn. In point of fact, I could not put it, as it would not be consistent with your Articles of Association [laughter]. He alluded to the resolution carried at this time last year, but he forgot to allude to the circumstances of the subsequent meeting. A gentleman on the other side said at the last meeting that if we had not been backed up by the proxies of the Globe Company and the Submarine Trust and so on, the Board would have been beaten. I beg leave to recall to that gentleman's memory what took place. We did not make use of proxies at all. We beat you by the votes of the room. [A Voice: "There was no poll."] There was no occasion for a poll, because the votes in the room were largely in favour of the Directors, 21 were in favour of the resolution, and 33 against it. [A Voice: "Including the Directors."] That having been the case, it is absurd to talk of a resolution passed a year ago when that was rescinded at a meeting six months ago. We have heard a great deal of criticism on the Articles of Association, and Mr. Abbott has stated that the shareholders have rights, as if the Articles of Association instead of being the charter of their rights were a confiscation. It seems to me that gentlemen who came into this Company as shareholders with the Articles of Association before them, knowing what those Articles are, have no right to turn round, and when met by the Board who are appointed to carry out those Articles say that we hurl them at their heads. Are the Board to go through their duties without any compass? The only direction we can have is the Articles of Association, which are well known to the shareholders [no, no]. Then all I can say is that they have acted very unlike men of business in becoming shareholders without knowing what the Articles are. However, the Articles are not like the laws of the Medes and Persians. They can be altered, but not by the mere vague talk of a meeting. The Articles of Association provide a means by which the shareholders, if they are dissatisfied with them, can honestly change them. Do that, and the Directors will bow to your decision. If we considered that the changes you made in the Articles were such that we could not conduct your business satisfactorily under these new Articles we should make our bow, and you would appoint other men to manage for you. But let me tell you that these Articles must be changed by the general body of the shareholders. It is absurd to talk about this meeting, large as it is, representing the whole body of the shareholders, because that is not the fact. There are 5,000 shareholders, all of whom must have a voice in the matter before these Articles are changed, and as long as they are unchanged it is my duty to see that they are not infringed upon, and if I did so I should forfeit any claim to your confidence. The Articles of Association, like the laws of any other body, protect you as much as they do the Directors. Mr. Prust has proposed a resolution that no portion of the reserve fund should be spent in new cables without the sanction of the shareholders at a general meeting. Well, that may be a very good, sound, and proper principle, but it is diametrically opposed to the rules on which you are operating.

A SHAREHOLDER: Do the Articles of Association empower you to spend our money without our authority?

The CHAIRMAN: I must continue my reply. Mr. Jackson asked a question as to the prospect of repairing cables that are down. I believe it is almost certain that they will be repaired; but Mr. Jackson knows as well as I do that this is a very unfortunate time of the year to go into the Atlantic and repair cables, and it is impossible to say within a week or a month when they will be repaired. They are, however, all new cables, and I have no doubt that they will be repaired. I am afraid as to another point I must fall foul of Mr. Jackson. He said we should not be actuated by law, but by equity, with respect to the renewal fund. Well, the Court of Equity would be precisely the machinery that would hold us, if we did not put by a sufficient renewal fund, probably personally liable. I think Mr. Chester asked a question as to the payments made to the companies during the period in which the cables in the "pool" were out of order. That is regulated by the provisions in the contract between the parties on entering into this arrangement of a joint purse. I have not in my mind at this moment the exact period; but I think that if the broken cables are not repaired within twelve months the payment diminishes. At all events a considerable time is allowed for the repair of the cables, and it is just as much in our interests as the interests of others, as it is just as possible that our cables might break as those of our competitors. Mr. Trower asked a question about amalgamation. I suppose it would lead to certain economies if an amalgamation took place, but our experience of amalgamation has not been very favourable, and I know that on the part of our confederates there is a very strong objection to it. I know it was made an essential condition of our union with some of them that they should be kept distinct, not with a view to benefiting the Directors, but with a view to the conduct of the traffic. Still, it is a question perfectly legitimate to discuss and consider, and may be brought forward hereafter. Mr. Newton spoke of the possibility, if the capital were reduced, of our not laying by so much to the renewal fund. But Mr. Newton ought to know by this time that it is not the amount of capital but the number of cables that regulate the amount to be put by to reserve fund. An appeal was made on the part of the holders of deferred stock, as if they were a greatly injured section of the community. But I wish for one moment to recall your attention to the time and mode in which that division between the preferred and deferred took place. That was not in consequence of the action of the Board, but was entirely brought about by a pressure of the shareholders themselves. Let me for a moment impress upon you this fact, that even if the principle was adopted by the Board it was not compulsory for any shareholder to divide his stock into preferred and deferred. If he did it he did it voluntarily, with the conditions before him. At the time the division took place no share was exclusive, deferred, or preferred, but all were ordinary shares; and every ordinary shareholder who changed his shares into preferred and deferred was possessed of an equal quantity of preferred and deferred stock, and if he parted with the preferred stock afterwards he did it for his own convenience. Therefore, I think that the deferred shareholders have no claim whatever on our benevolence. A question was asked as to the amount of interest yielded by the reserve fund last year.

The SECRETARY: The amount yielded in 1884 was about £3 12s. 6d. per cent.

The CHAIRMAN: The wages are between £600 and £700 less than last year. But Mr. Seeley would be the last man to try and get us to take work out of our men for nothing. The number of our *employés* is from 350 to 400.

A SHAREHOLDER: Have the Directors power to alter the Deed of Association without the consent of the shareholders?

The CHAIRMAN: Certainly not. The Articles of Association can only be altered by a special meeting called for the purpose by the shareholders, a majority of three-fourths must concur.

He then put the resolution, and declared it carried by 55 to 21. He further added that he would put Mr. Prust's resolution as a recommendation to the Directors, but he could not put it as proposed.

Mr. SMITH: There is no use of our recommending anything.

Mr. PRUST said that he would stand by the resolution as he had proposed it. That was what he wished.

The CHAIRMAN then put Mr. Prust's resolution as a recommendation to the Board, and said that as far as he could see there were 44 for it and 41 against it, and therefore it was carried.

On the motion of the CHAIRMAN, seconded by the VICE-CHAIRMAN, Sir James Anderson was re-elected a Director.

On the motion for the re-election of Mr. W. G. Cunard, Mr. ABBOTT moved an amendment to the effect that Mr. Cunard be not re-elected, and this was carried by 43 to 23.

Mr. BEVAN (a director) demanded a poll on the question.

Mr. BAKER: Do you intend using your proxies on this?

The CHAIRMAN: Yes ["Shame"].

The Auditors were next re-elected.

Mr. WM. ABBOTT moved a resolution, notice of which he said he had sent to the secretary on the 15th ult., in effect requesting the resignation of Mr. Cyrus Field from the Board, so that some gentleman not identified with any competitive scheme might be appointed to his seat.

Mr. PRUST seconded the motion.

The CHAIRMAN and MANAGING DIRECTOR both spoke strongly against the resolution, and an amendment was moved to the end that Mr. Field should have an opportunity of replying to the charge brought against him. The amendment, however, was lost, and Mr. Abbott's motion carried by 39 to 33, a poll being afterwards demanded and taken.

At the adjourned meeting, held on Saturday, at the Company's offices, Lord MONCK said that the result of the polls for the re-election of Mr. Cunard and the resolution proposed by Mr. Abbott respecting Mr. Field was as follows:—Amount of stock in favour of Mr. Cunard and Mr. Field £2,576,795; number of votes, 34,877; number of voters, 1,068; against Mr. Cunard and Mr. Field, stock, £10,756; number of votes, 165; number of voters, 3. There was thus a majority in favour of Mr. Cunard and Mr. Field of £2,566,039 stock, 34,712 votes, and 1,065 voters; and accordingly he declared Mr. Cunard duly re-elected a member of the Board, and that the resolution moved by Mr. Abbott was lost by a majority of 1,065 to three voters.

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The British Insulite Company.

The annual general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Tuesday last, under the presidency of the Right Hon. E. P. Bouverie.

The SECRETARY (Mr. E. Dolby) read the notice convening the meeting, and the report of the Directors and statement of accounts were taken as read.

The CHAIRMAN, in moving the adoption of the latter, prefaced his observations by expressing his regret and that of his colleagues that, through a printer's blunder, the date of the meeting had to be altered from the first Monday in February till that occasion. He had also to express disappointment on behalf of Sir George Richards that in consequence of the blunder in question he was unable to be in his place at the Board, and at the same time that gentlaman's entire concurrence with the course that the rest of the Directors proposed to pursue. He (the Chairman) then said that it was not an agreeable thing for the Directors to have to present accounts to the shareholders of this Company which showed a considerable loss. They had indulged the hope last year that the result of another year's operations would have enabled them to turn the corner. They had some grounds for so thinking, and they were confirmed in that view also by the opinion of a very experienced man in the City—their auditor—whom they requested to examine into the state of the Company's books, and to give his opinion, which was at all times a very good and reliable one. Looking to the question in its main features he (the Chairman) felt convinced that the loss of so much money on the part of this Company was due to the complete failure at present of all efforts for general electric lighting [no, no]. Honourable shareholders might say "no, no," but he must be permitted to express his opinion at any rate, and that was his distinct opinion. He thought he could show some reasons for so thinking. The fact was that all electric lighting business, having at one time promised to be a very big affair, had been entirely crushed out by what was called the Electric Lighting Act of 1882. The public were always jealous of monopolies, but were unaware of the advantage they had derived from having given monopolies in old times to companies when they were embarking in any great enterprise for the public benefit. He ventured to say that if the same jealousy had been felt and the same practical effect given to it at the outset against the railway companies of this country, or against the development of gas or water companies, there certainly would not have been anything like the railway system they now enjoyed in this country, or the advantage that had arisen from supplying their towns with gas and water. It was the very fact of the new outlet of capital promising new and excessive returns that induced people to go into undertakings; but if the public stepped in and laid hands beforehand on any excessive profit made by those who ventured on such new undertakings they stopped the work being carried on altogether. That was the effect of the Electric Lighting Act, which provided that after a certain period the whole of the profits of the Electric Lighting Companies were to be absorbed by the public authorities, and nothing was to be allowed them in respect of the goodwill of the business the Company had still to create. Still, in the first instance, the view entertained by those who started this Company was that their invention would be largely applicable to the purposes of general electric lighting. One electric railway at work in Ireland had resorted to their material for the insulation of its conductors, and for some electric lighting which was done last year at Buckingham Palace and the West of England the people who completed the arrangements had recourse to the Company for its material to insulate their conductors, which was done in a way that could not have been effected by anything else at a similar cost. That circumstance showed quite clearly that if there had been a large demand for the electric light the Company would have greatly benefited by it. But of course their vast source of expected advantage was destroyed for a time by the Act referred to, and they had to look about for fresh business and to ascertain whether it would not be possible to apply their material to various subordinate electric appliances for which it was of great use, and they did so. They had manufactured these to the great satisfaction of the people who used them; but, unfortunately, the demand for anything of that kind, unless it was excessively stimulated by adventitious means, could not be expected to pay, and it had been too limited to return profit to the Company and stand the cost of establishment, manufacture, offices, and so forth. It required a very large area of business to make such an undertaking remunerative. [The Chairman here read one or two extracts from letters received from gentlemen who had used the material, bearing testimony to its quality and its suitability for the purposes of an insulator.] Nevertheless, he said that the result of their experiments had shown that they could not manufacture it except at a loss under the present state of demand. He thought it might have been possible, by dint of advertising, puffing, and canvassing, to have got up a demand for it. They to a certain extent tried that, but they were, of course, hampered by limited means and their unwillingness to squander the money of the Company without a good result, and the consequence had been that the area of business had remained very much as it was, although they had reduced expenditure, &c. The outcome was unsatisfactory, as they would see by the report. They had then, as directors, to consider what had best be done. Instead of making two speeches, he would anticipate what he would have to say at the extraordinary meeting to be subsequently called. They had been landed in a considerable loss, and the question for them to consider was, whether it was for the advantage of the shareholders and themselves to continue to manufacture, and to endeavour, if possible, to turn the corner, and make a fresh call and so recoup their losses. He ought to mention that the Directors had the strongest possible interest in the matter. The gentlemen sitting on his side of the table were not merely there because they had staked their own character upon working the thing respectably and honestly, as he hoped they had done, but they had also a very large holding in the Company. Therefore they had every possible motive as they conceived, in the first place, to try and make the thing a success, and in the next place to form the soundest judgment they could with respect to the future. After deliberating, they came to the conclusion that the best thing for them to do was to recommend the shareholders, as they were to do to-day, to liquidate the Company. Taking their assets at a reasonable estimate they could more than pay everything they owed. One fact in their favour was that they had only two debts, one was to their bankers, and the other was to the Directors themselves. The Directors had never from the first drawn any of their fees, not wishing to embarrass the Company. The item of sundry creditors showed the amount, namely, £2,891, of which £2,600 was due to the Directors. There was, therefore, only £300 due to sundry creditors, and the only debt they owed was that to their bankers. Against that they had some valuable property. He did not propose to put an estimate on the patents, but he might say on the part of the Board, as was intimated in the report, that they still held that those patents might yet become very valuable in a change of circumstances. There was no doubt about the material, its scientific value, and its utility, as tested by experience. Therefore it was quite possible that the patents in better times might become valuable, and they hoped to reserve them for the benefit of the shareholders of the Company, and would hold them in trust for that purpose. They then had their property at the works, which they had bought very cheap, and which was now worth considerably more than they paid for it. There were exceptional facilities there affording access to the river and to the railway, and it was completely isolated, besides being beyond the jurisdiction of the Metropolitan Board of Works, all of which circumstances gave it an increased value. Then they had their machinery, some of which was valuable. They had a small amount of cash, and some arrears of call to get in, and altogether their assets might be estimated at from £7,000 to £8,000. He thought that under these circumstances there would be no further call on the shareholders, but possibly a small return to give them. He concluded by expressing regret that he and his colleagues had not been able to make the Company a success. It certainly had not been due to any want of desire or effort on their part, but rather to those adventitious circumstances already mentioned, over which they had no control—circumstances which he thought it was quite possible might change before long, and give a value to their patents something more nearly approaching what the shareholders originally hoped than what they could possibly reach now.

Mr. MOORE seconded the motion.

The CHAIRMAN, in reply to questions, said that the Directors did not propose to ask for their fees. As to their leasehold property, valued at £2,754, they gave originally £1,800 for it, but they had added to its value by improving the buildings, &c., and they believed it was worth a great deal more. They had 32 years of their lease to run, and the rent was £90.

Mr. PERRING asked whether there would be any further call.

The CHAIRMAN said he could not give an emphatic assurance that there would not be, but he repeated that he believed there would be sufficient assets to obviate that contingency. The wages had amounted for a considerable part of the year to £30 or £40 a week, there being a certain number of men employed at the works; but the item of salaries was not quite what was generally understood by that term. A large portion of the sum disbursed under that head was paid to travellers, of whom they had five at one time working on a salary. Half of the amount might be put down to that. In further reply to questions, the Chairman said that the works had been all stopped, although there was one man looking after them.

Mr. PERRING: Has anybody been looking after the works with a view to buying them?

The CHAIRMAN answered in the negative, giving as a reason that the property had not been put into the market yet. He was inclined to think that, if there was any possible chance of their resuming operations with a probability of profit, it would be very desirable to retain the works, because they would never get such a favourable location again.

The motion was then put, and declared carried.

The meeting was afterwards made extraordinary, and

The CHAIRMAN moved the following resolution:—"That the Company be wound up voluntarily under the provisions of the Companies Acts, 1862 to 1880, and that Samuel Lowell Price, of 44, Gresham-street, in the City of London, chartered accountant, be and he is hereby appointed liquidator for the purposes of such winding up."

Mr. JOHN CLARK seconded the motion, and took occasion to pay a high tribute to the Directors for the way in which they had strenuously endeavoured to save the Company from collapse.

The Hon. CECIL JOHNSTON briefly addressed the meeting, and said that having carefully examined the affairs of the Company he was persuaded they possessed a good concern, and thought it was very unfortunate to go into liquidation at all. He was quite prepared to support the Board with fresh supplies in proportion to his holding, to help them to carry on the works, if the other shareholders would do the same.

The CHAIRMAN pointed out that the wishes of the great body of the shareholders had to be consulted, and he did not think it would be fair to call upon them, since the manufactory was not paying, to contribute anything more at the present time.

After a brief and unimportant discussion the motion was put to the meeting and carried, and the proceedings terminated.

National Company for the Distribution of Electricity.

The second ordinary general meeting of this Company was held at the offices of the Company, 18, Warwick-street, Regent-street, on the 9th inst. The report of the Directors explained the expenditure that had been made on the Metropolitan and Turin-Lanzo railways over circuits respectively of fifteen and fifty miles, which, though yielding no profit,

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had proved the system. The Directors announce the commencement of a large installation by a company formed by Sir Coutts Lindsay for the house to house distribution of light in Bond-street and the neighbourhood by means of the system of secondary generators. Under a temporary arrangement, part of the Grosvenor Gallery and some neighbouring shops are already lighted by this system. The installation at Turin which obtained the first prize of £400 and a gold medal at the International Electrical Exhibition, has led to important and valuable business. It was also stated in the report that the Company is now prepared to transmit and distribute mechanical power by means of their secondary generators. Looking to the business in hand and that in prospect, the Chairman anticipated that the coming year would yield profitable results to the Company.

The meeting closed with the usual votes.

Submarine Telegraph Company.

The Directors' report shows a result which enables them to add £8,026 0s. 5½d. to the reserve fund, and to recommend a dividend at the rate of 14 per cent. per annum, and to carry forward a balance of £377 18s. The receipts for the six months are less than those of the corresponding period of 1883 by £682 0s. 2½d, owing to the shorter length of the messages transmitted, and to the receipts from the wire leased to the Indo-European Telegraph Company not having been so large as in 1883. On the other hand there has been a small increase in the sum paid by the French newspapers which lease special wires during the night for their correspondence. The expenses for the half year have been £1.969 14s. 2d. more than in 1883, arising from an increase in the cost of repairing the cables and the Company's steamer, law charges, the increased pay to the telegraph clerks and others in the employment of the Company, and the increased sum the Company has now to pay to the French Administration for working the circuits between the French coast stations and London. In the course of the half year there has been inserted in the Company's cables to Ostend and Dieppe two knots of new cable, but fortunately no expense has fallen upon the Company in connection with the Government cables in the North Sea. The new cable laid down by the Post Office to Holland has been in good working order, but the other cable to Holland is now interrupted.

The meeting of the proprietors takes place on the 17th February, at 1 o'clock, at the Company's Offices, 2, Throgmorton-avenue, E.C.

The South Eastern (Brush) Electric Light Company.

The committee appointed at the general meeting held on 22nd December last (consisting of Messrs. W. Hewett, jun., C. H. Stewart, and A. L. Riddell) to inquire into the present position of the Company beg to submit the following report to their fellow shareholders :—

The balance sheet presented at the above meeting being only made up to 30th June, 1884, the committee requested Messrs. Price and Waterhouse, the auditors of the Company, to prepare an approximate balance sheet and report on the accounts for the half year ending 31st December last. From these documents the committee have summarised the following figures, which will show approximately the present financial position of the Company.

	£	s.	d.
To Paid-up Capital	40,615	0	0
By Concessions, Preliminary Expenses, and Expenditure in obtaining Provisional Orders	14,711	4	7
By Colchester Installation and Plant	7,388	7	5
By Stock and Office Furniture and Office Installation	1,941	2	11
By Sundry Debtors, Creditors, and Bills	263	19	5
By Cash advanced to Consolidated Company against Debentures and Shares	7,000	0	0
By Interest due by ditto	691	4	5
By Losses on Working to 31st December, 1884	8,175	16	9
By Cash at Bankers and in hand at 31st December	443	4	6
	£40,615	0	0

Of the total paid-up capital of upwards of £40,000, therefore, practically nothing now remains but the breaking up value of the Colchester installation, the stock, furniture, and office installation, and the debentures and shares of the Consolidated Company. The capital expenditure at Colchester amounts, as above stated, to £7,388 7s. 5d., and the results of the working of the installation since its inauguration are as follow :—

	£	s.	d.		£	s.	d.
Station Expenses to 30th June, 1884	703	1	9	Receipts for same period	226	1	10
Do. to 31st December, 1884	514	18	11	Do. do.	168	9	0
					£394	10	10
				Debit Balance	823	9	10
	£1,218	0	8		£1,218	0	8

The installation has therefore already cost the Company £823 9s. 10d. actual loss on working, without reckoning anything for depreciation of plant (a very large item), or interest on capital sunk, which last item at 5 per cent. since June, 1883, would represent a further sum of over £600.

Under the agreements with the Consolidated Electric Company it would appear that the South Eastern and Provincial Companies are bound to make cash advances to that concern to the extent of £10,000 each. Of this sum this Company and the Provincial have already paid each £7,500. The balance has recently been called up and will doubtless have to be paid. For these cash advances the two companies hold debentures as well as one-fifth each of the nominal share capital of £100,000 (say £20,000 each). The Consolidated Company has been debited with the interest upon the debentures in the books of the South Eastern and Provincial Companies and the amounts carried into profit and loss as an asset. No actual payment to either company has in fact been made, as there are at present no ascertained profits of the Consolidated Company. The committee are informed by the Board that the £15,000 received by the Consolidated Company is now wholly represented by patents acquired by that company, and by the plant and fittings of the factory in Cow Cross-street. As to the intrinsic value of these assets it is impossible for the committee to offer any opinion.

In view of the disastrous results so far, and the certainty that a continuance of the present policy must lead to the calling up of the whole of the unpaid capital, to be followed by the compulsory liquidation of the Company at no distant date, the committee are unanimously of opinion that immediate steps should be taken for the purpose of trying to save what remains of the property of the Company. In the opinion of your committee this can best be done by the voluntary liquidation of the Company forthwith. The liquidators can make any arrangement which may be practicable with the Anglo-American Brush Corporation, and it will be their duty to divide the remaining assets of this Company in as inexpensive and expeditious a manner as possible. Your committee are glad to see that their recommendations are not to be opposed by the Directors, as will appear by the following letter addressed to the solicitors of the committee :—

The South Eastern (Brush) Electric Light and Power Company, Limited, 68A, Cow Cross-street, London, 5th Feb., 1885.

Messrs. Blewitt and Tyler, 79½, Gracechurch street, E.C.

DEAR SIRS: The Directors have to-day further considered the position of the Company with reference to the views entertained by the committee represented by you, and they are prepared to concur with your committee in endeavouring to make such an arrangement with the Anglo-American Brush Corporation as will be satisfactory to the shareholders ; failing which the Directors will not oppose any proposition which may be approved at the adjourned general meeting for either winding up the Company voluntarily, or carrying it on at a minimum expense.—Yours, faithfully,

The South Eastern (Brush) Electric Light and Power Company, Limited.

GEO. OFFOR, Manager.

Your committee in no way coincide with that part of the above letter which suggests a future carrying on of the business.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. FEB. 11.		BUSINESS DONE WEEK ENDING FEB. 11. Highest.		Lowest.
Anglo-American	30½,	31½	31¾		31
Do. Preferred	55,	56	56		55
Do. Deferred	7¾,	8¼	8 3-16		7¼
Brazilian Submarine	10¾,	11½	11 1-16		10 15-16
Cuba	10¼,	11¼	11¼		—
Do. Preference	17½,	18½	18		17¾
Direct Spanish	2,	2½	—		—
Do. Preference	12,	13	12		—
Direct United States Cable	9⅜,	9½	9⅝		9
Eastern Telegraph	11⅞,	12¼	12		11⅝
Do. 6 per Cent. Preference	13¼,	14¼	—		—
Do. 5 per Cent. Debentures, 1899	105,	108	107		—
Eastern Extension	12⅜,	12⅞	12⅞		12½
German Union	9½,	10	—		—
Globe Telegraph and Trust	6¾,	7½	7 1-16		6 13-16
Do. Preference	12½,	12⅞	12⅞		12½
Great Northern	14¾,	15½	14 15-16		—
Indo-European	32,	33	32⅝		—
Reuter's	7½,	8	—		—
Submarine	185,	190	—		—
West India and Panama	⅝,	¾	—		—
Do. 1st Preference	7½,	7¾	—		—
Western Brazilian	6⅜,	6⅝	6 9-16		6½
Western Union 7 per Cent. 1st Mortgage	120,	125	—		—
Do. 6 per Cent. Sterling Bonds	100,	103	101½		—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	—		—
Oriental	½,	⅝	⅝		—
United Telephone	11,	11½	11⅝		11

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1¾	2		1 7-16
Do. (fully paid)	3,	3½	—		—
Hammond Light (£3 15s. paid)	⅝,	¾	11-16		⅝
Swan	½,	⅝	—		—
Maxim-Weston	½,	½	5-16		—

MISCELLANEOUS.

Telegraph Construction	34½,	35½	35½		34¾
India Rubber, Gutta Percha, and Telegraph Works	21,	22	22½		21 15-16

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NOTES.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 13th February amounted to £3,772.

PNEUMATIC TUBES.—The Post Office telegraphs are largely dependent upon pneumatic tubes. In the metropolis no less than 29,801 messages were forwarded by the tubes, against 26,162 by wire, on the same day.

DIRECT UNITED STATES CABLE.—Communication, "*viâ* Direct Cable," with the United States of America, Canada, the West Indies, and Central and South America, is re-established, the main cable having been repaired.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 13th February were £3,056, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

SIXPENNY TELEGRAMS.—The additional number of telegraphists to be engaged by the Post Office, in order to meet the requirements of the increased traffic, is from 1,200 to 1,300. This does not include those operators who may be engaged by provincial postmasters.

N. S. W. TORPEDO AND SIGNALLING CORPS.—The *Daily Telegraph* says that the Torpedo and Signalling Corps of New South Wales consists principally of men belonging to the Electric Telegraph Department, and is regarded by competent judges as a most efficient body.

THE SPANISH EARTHQUAKES.—A telegram received at Madrid on Friday from Jaen, reports that a shock of earthquake was felt the previous day at Torre Del Campo. The church, hospital, and one house sustained serious damage; but there were no casualties among the inhabitants.

LIGHTING OF FRENCH TRANSPORTS.—Among the steamers hired by the French Government for the transport of the troops to Tonkin are the "Château-Yquem" and "Château-Margaux," owned by the Compagnie Bordelaise de Navigation, each vessel being lighted throughout by about 200 incandescent lamps.

GENERAL TELEPHONE COMPANY.—During the week ended February 5th, the Société Générale des Téléphones registered 17 new subscribers in Paris alone, while communication was afforded to 14 subscribers previously booked. The 375f. (£15) paid-up shares, which were quoted at 370f. on February 2nd, rose to par on 9th inst.

ELECTRICAL STREET CARS.—It is said that the electric motor for street cars will soon be an established institution in Cleveland. Arrangements are now being made by the East Cleveland Street Railroad Company to use the Knight-Bentley system on Cedar, Euclid, and Garden streets. The electric lines will, it is said, be in operation within three months.

HOUSE LIGHTING AND HEATING.—Mr. E. H. Johnson, president of the Edison Electric Lighting Company, has his private residence lighted with incandescent lamps. The dynamo is in the cellar, and is said to make so little noise that it cannot be heard on the floor above. A small engine drives the dynamo, and the exhaust steam is used for heating the house.

RIVER STEAMER LIGHTING.—A company has been formed in Paris for running a new line of boats on the Seine. Each of the 32 steamers composing the fleet will be lighted by Bosquet with twenty-two 16-candle incandescent lamps, supplied by a Gramme dynamo modified by M. Raffard, which, at 950 a minute, gives out an E.M.F. of 110 volts at 18 amperes.

ELECTRICAL CHAMBER OF COMMERCE.—The Chambre Syndicale de l'Electricité at Paris languishes for want of sufficient members to give weight to its decisions; but, in view of the new law extending the power and functions of *chambres syndicales*, the president, M. Armengaud, junior, has called a meeting of all interested in reconstructing this syndicate of the electrical industries.

SOCIETY OF TELEGRAPH ENGINEERS.—A meeting of this society will be held in the hall of the Institution of Civil Engineers, 25, Great George-street, S.W., on Thursday, 25th inst., for discussing Mr. Illius A. Timmis's paper, "On the Working of Railway Signals and Points by Electro-Magnets," &c., and hearing a paper "On Constant Electromotive Force in an Electric Light Circuit," by Sir David Salamons, Bart.

ELECTRO-CHEMICAL BLEACHING OF PAPER.—M. E. Hermite has put up, at some paper mills in France, a shop for bleaching paper by the decomposition of chloride of magnesium by the electric current. It appears that a liquid is thus obtained which possesses high decolorising properties, the salt being regenerated as the process of bleaching proceeds, so that, at the end of one operation, the same bath serves for another.

COMMUNICATION WITH THE WEST INDIES AND BRITISH GUIANA.—The cable between St. Croix and Trinidad is interrupted; and, as the cables between St. Kitts and Antigua, between Trinidad and Demerara, and between Antigua and Guadaloupe are not yet repaired, there is at present no telegraphic communication with Antigua, Guadaloupe, Dominica, Martinique, Sta. Lucia, St. Vincent, Barbadoes, Grenada, Trinidad, and British Guiana.

HEAT OF COMBUSTION IN CARBONS.—M. Berthelot and M. Vieille have been experimenting as to the measure of combustion heat in various carbons. A calorimetric bomb was employed, containing three times the amount of compressed oxygen required to effect combustion in air. In the bomb the combustion is complete, lasting for two or three minutes and generating no carbonic oxide. In this manner the measure of heat was obtained with great accuracy.

ELECTRIC EELS.—It is said that a well-known scientific man has ordered from a Liverpool dealer a hundred electric eels for the purpose of studying their powers. Hitherto the nature of the marvellous emanation that has generally been accepted as electricity has not been fully investigated. Although the *gymnotus electricus* is capable of giving a shock not practically distinguishable from that of a galvanic battery, there is now some reason for doubting the identity of this power with a veritable electric shock.

ELECTRICAL APPARATUS FOR PREVENTING COLLISIONS.—The Director of Swedish Railroad Telegraphs has invented an electric apparatus for preventing collisions. The instrument is attached to the rails at certain places and connected by a telegraph wire with the station, where it communicates with a small needle instrument. When a train passes the spot where the instrument is placed, an electric circuit is opened; and the needle indicates the spot where the train happens to be at that moment.

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NATIONAL TELEPHONE COMPANY.—We have received the February issue of the Dundee district list of subscribers to this company. The first telephone was put up at Dundee in 1879; and there are now in operation in the district 785 telephones and 507 miles of wire, while there are about 1,500 subscribers. We have also received the 11th or January issue of the list for the Aberdeen or Scottish North Eastern district. The first telephone was put up at Aberdeen in 1881; and there are now in operation nearly 450 instruments, the number of subscribers being about 400.

TELEPHONE EXPERIMENTS AT LIMERICK.—In the course of some experiments made at the Limerick Post Office Telephone Exchange, under the authority of the postmaster, Mr. Conway, communication between Limerick and Cork, a distance of over sixty miles, was established by means of the existing telegraph wire connecting the two cities, and with a result proving that conversation can be carried on with perfect success between these points. The articulation is said to have been quite distinct, operators at either end of the line, personally acquainted, being able to recognise each other's voices.

SURPLUS FROM THE PARIS ELECTRICAL EXHIBITION.—A decree of 24th February, 1882, affected the sum of 325,000fr. (£13,000), profit made on the Paris Electrical Exhibition of 1881, to the foundation of a central electrical laboratory; but it appears that administrative difficulties have hitherto prevented the carrying of this useful measure into effect. The most astonishing part of the story, says the *Bulletin International des Téléphones*, is that every one is agreed in recognising its utility, the Paris Municipality having promised to give the necessary land; and yet the matter is not taken in hand.

LIGHTING OF THE EMBANKMENT.—"Alsatia" writes to *The Times* that, since the abolition of the electric light on the Thames Embankment, only half the parapet gas lamps are used, and most of the burners are very much worn. The writer directed the attention of the authorities to the matter in July, and received an official reply on August 15th, to the effect that the question of "lighting by electricity was under the consideration of a committee, and that as soon as their report is received the Board will decide upon the best course to be adopted for the lighting of the Embankment."

CURATIVE ELECTRICITY.—Dr. Berkholz, medical director of the Commandanten-Strasse Baths, Berlin, has successfully treated, by electric current, both rheumatism and various cerebral and nervous affections. He employs both induced and galvanic currents, the intensity of which is regulated to suit individual cases, the electric bath lasting a quarter of an hour. If the action is to be general, one of the electrodes is put in connection with the bottom of the bath, while the other is held by the patient's hands; but if it is to be local, the part affected is placed between two large copper electrodes.

NEW STORAGE BATTERY.—An electrical storage battery similar to that of Faure has been, it is said, designed by Mr. N. S. Keith. It is proposed to employ it for electric lighting, and also to run motors and street tramcars. It is claimed for this invention that fully 70 per cent. of the power generated can be used in an ordinary street car, while with the cable systems only 32 per cent. is available. Very little change is necessary to apply electricity to cars previously drawn by horses. One of the San Francisco systems of street cars is about to be run by the new electric Keith motors and storage batteries.

THE TELEPHONE IN SWEDEN.—According to the *Bulletin International des Téléphones*, Sweden is probably the country where telephonic communication has been developed with the greatest rapidity. At the end of 1882 there were only 1,554 subscribers; but at the end of last year the number rose to 7,737, giving an increase in two years of 6,183. The most important stations are those of Stockholm with 3,796 subscribers, Gothembourg 738, Malmoe 355, Nordköping 208, Sundswall 180, Upsala 139, Visby 113, and Orebro 100, while the telephone is also installed in forty-three other localities of minor importance.

ELECTRIC LIGHT AT BRIGHTON.—At the meeting of the shareholders of the Brighton Grand Hotel Company on the 16th inst., Mr. William Sharp, who presided, stated that they had been trying the electric light at the hotel, in the drawing room and the coffee room. He might state that the result had almost fully answered their expectations—not quite, however, as it was impossible to please everyone. Some of the old ladies, for instance, said it was too cold; and then when they lighted the gas some of them said it was too hot. He thought, however, that the introduction of the electric light might be regarded as a great improvement at the hotel.

IMPERSONATING ELECTRICIANS.—At Wimborne Police-court, on Monday, Henry Everest, *alias* Edison, *alias* Siemens, was brought up on remand, charged with obtaining food, firing and lodgings, to the value of 12s. from Mrs. Caroline King, by falsely representing that he was a son of Mr. Edison, the great electric light originator. On being found out, he decamped from Wimborne and went to Poole, where he was found by Police-Sergeant Cantle playing the same game, having there represented that his father was Mr. Siemens. Prisoner, who is about 21 years of age and the son of respectable parents in Reading, was committed for trial at the quarter sessions.

SHIP COMMUNICATION BY CABLES.—The idea of the French engineer officer for enabling vessels upon the high seas to communicate with the shore by means of existing submarine cables is of too precarious a nature for the project to be of any practical value. He proposes that the cables be supplied at convenient intervals with short branches, with the free ends buoyed so that passing vessels, with the necessary batteries and a key for obtaining access to the wires, may telegraph home. However, experiments to test the feasibility of the scheme are to be undertaken; and several branches are being attached to the cable which connects Algiers with Marseilles.

GENERATORS OR TRANSFORMERS?—Under this head *L'Electricien* reproduces the Italian text of the Turin Exhibition jury award to Gaulard and Gibbs for their batteries. The following is a translation:—Although the transformation, by means of the induction of weak currents into more intense currents, is not a new problem, the jury acknowledges that the latest form given by M. Gaulard to the induction apparatus is very rational, and permits of realising this transformation with but slight loss of energy. Wherefore it hands over to the Società di Generatori Secondari 10,000 *lire* (£400) by way of encouragement to bring to perfection this system, which readily lends itself to the distribution over large areas of all kinds of electric lighting.

BUTTER BY ELECTRICITY.—Mr. A. C. Tichenor has lately patented a process by which a current is passed through milk contained in a vessel of special form, and butter is formed in little balls on one of the electrodes. It is said that to extract the butter from 45 litres of milk the current from a dynamo-electric machine equivalent to that of about 40 Daniell cells for, from three to five minutes, is all that is required. With such a current, the balls of butter are suffi-

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ciently voluminous to detach themselves from the electrode and float to the surface of themilk; but the butter thus obtained has still to be churned, so as to work the small pieces into a compact mass. We very much question the feasability of such a method of butter-making.

NEW HOLDER FOR INCANDESCENT LAMPS.—We have received from Messrs. Harrison, Cox-Walker, and Co., a new holder, which is so constructed as to make the best possible contact between the loops and the terminals in the holder. At the same time it grips the loops in such a way as to render them less liable to be broken, and also provides an additional support for the lamps where considered desirable. The body of the holder is three-quarters of an inch square, with a deep groove across the middle, in which are fixed flat nipping springs, or pieces of metal, to which the terminals are attached. The loops in the lamps are placed between the springs, two milled-headed screws nip the springs together, and thus hold the loops by the sides perfectly tight, making good electrical contact.

PORTRUSH ELECTRIC RAILWAY.—At the half-yearly meeting of the Giants' Causeway and Portrush Electric Tramway Company held on the 17th inst., the report stated that there was an increase of passengers over the corresponding half of last year amounting to 1,331, with an additional 391 tons of goods and minerals. The receipts were £1,693 5s. 7d., as against £1,554 4s. 7d. last year; and the receipts for the past two years have shown an increase of £338 2s. 8d. The directors recommend a dividend of 3 per cent. on the preference stock, carrying forward a balance of £81 18s. The report was adopted; and, at an extraordinary meeting held subsequently, a resolution was passed approving of a Bill now before Parliament to enable the company to abandon part of their authorised railway and to construct a new one.

FORTIN HERMANN'S CONDUCTORS.—The inventor of this system has sought to combine the advantages of the air line with those of the underground cable. Starting from the fact that the G.P.-covered air line permits of the most rapid transmission possible through the best insulating medium, M. A. Fortin Hermann considers he has found means for counteracting disturbances and atmospheric influences while preserving the dielectric properties. The conductor is inserted in small wood cylinders touching one another by the ends, and thus forming a chaplet or chain, covered by sheet lead or inserted in a lead pipe. This mode of construction permits of placing the conductor indifferently in water, the earth, a sewer, or the air; even under the influence of a high temperature, limited only by the point of fusion of the lead covering, the line is free from atmospheric influences.

LIGHTING AT THE MANSION HOUSE.—The lighting plant for the Egyptian Hall and Saloon of the Mansion House by the Hammond Electric Light and Power Supply Company consists of 142 incandescent lamps in the hall, viz., thirty-four round the edge of the cornice, about 6ft. apart, and 108 on the chandeliers between the columns; with 127 lamps in the saloon, viz., twenty-six in the dome and the remainder on the chandeliers. The current is supplied by two Ferranti dynamos, one to each hall, driven by two 12-horse Clerk patent gas engines, made by Sterne and Co., of Glasgow, the two engines working on to one countershaft. This method, together with driving pulleys having very heavy rims used as fly-wheels, aid greatly in steadying the light. The generating plant is fixed in the cellars of the Mansion House, a work of some difficulty, as they consist of a series of small arches.

REYNIER ACCUMULATORS.—M. Reynier has established at Friburg, Switzerland, a manufactory of accumulators, which are to be of two kinds, one, devised by himself, with zinc and lead electrodes, and the other with lead plates only, after Planté's method. The usual type contains three pairs of plates, and weighs half a cwt. M. Reynier considers that he is able to store up 86,000 kilogrammetres (622,050 foot-pounds), which corresponds to a capacity of 3,440 kilogrammetres per kilogramme of accumulator, or roughly 10,000 foot-pounds per pound (including lead, glass and liquid). As each plate weighs 2·8 kilogrammes, this corresponds to a capacity of 5,120 kilogrammetres per kilogramme, or 16,878 foot-pounds per pound, of lead. Thus, remarks the *Bulletin International des Téléphones*, it has been found possible to get 19 horse-hours out of a ton of lead, a feat hitherto unaccomplished.

WILDMIER ELECTRIC BRAKE.—Successful experiments were lately made at Cincinnati with this new electric railway brake. The tests were made on the Cincinnati, Washington and Baltimore division of the Baltimore and Ohio Railroad, under the immediate supervision of I. H. Stewart, general manager, and I. E. Rose, master of transportation. The special trial was made with a heavy coal train of 10 cars, each weighing empty about 11 tons, and having a capacity of 40,000 pounds. The brakes were only applied to the freight cars and caboose, there being none on the locomotive or superintendent's car, and no hand brakes were used. The loaded train, with full steam on, was put to a speed of 48 miles an hour on a downward gradient of 68ft. to the mile, and was brought to a stoppage in 37½ seconds after putting on the brake, the exact distance run in that time being 445 yards. The brake would act automatically in the event of the train parting.

SOUTH EASTERN (BRUSH) ELECTRIC LIGHT AND POWER COMPANY.—Mr. W. Hewett, jun., and Mr. Braithwaite have issued the following circular:—"Having regard to the Committee of Investigation, it seems to us that, in the interests of shareholders, the sooner this company is wound up the better for all concerned. The letter of the manager referred to in the report of the committee seems to foreshadow an attempt to carry on the company. In order to bring the matter to an issue and to obviate any possible further delay, with its consequent expense, we would ask you to sign and return as soon as possible to Mr. W. Hewett, jun., of 14, Fore-street, E.C., the enclosed requisition. We appeal with the greatest confidence to the shareholders, as we feel sure that it is only by promptly following up the recommendations of the committee, and by stopping the further operations of the company, that any portion of the remaining uncalled capital can be saved."

GUTTA PERCHA FAMINE.—In presence of the scarcity of this, the best known insulating substance, the French Minister of Posts and Telegraphs has sent one of his engineers, M. Séligmann-Lui, to the producing countries, with instructions to report on the possibility of cultivating gutta percha in French Cochin China. The following are the conclusions arrived at in the report to M. Cochery:—Justly anxious about the state of things as regards electrical industry, you hoped that Cochin China might afford fresh supplies; but, unfortunately, this is not the case. Since it is certain that all the countries which produce the guttifers already yield us their supplies, and since excessive demands have in a few years destroyed the reserves accumulated during centuries in the Malayan forests, since the present is without remedy and even the future com-

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promised, it is necessary to take measures immediately, otherwise a substance will soon be found wanting for which no substitute has yet been discovered.

LIGHTING OF STEAM HOPPER BARGE.—The Liverpool Corporation has invited tenders for electrically lighting the steam hopper barge "Beta," the specification and plans for which have been prepared by the city engineer. Copies of the form of tender may be obtained from Mr. John Denton Fisher, chief clerk, at the city engineer's department. Sealed tenders, which are to be on the official form, and endorsed "Tender for Lighting by Electricity Steam Hopper Barge 'Beta,'" must be addressed to the Chairman of the Scavenging Committee, and delivered at the City Engineer's Office, Municipal Offices, Liverpool, not later than Saturday, 7th March. The successful tenderer will be required to enter into a contract, to be prepared by the town clerk, and, as the Corporation may direct, either provide approved sureties for the due performance of the contract, or deposit an amount equal to 10 per cent. of the contract price; and the lowest or, indeed, any tender will not necessarily be accepted.

JOURNALISTIC PIRACIES.—Our esteemed contemporary, which combines an expressed belief in the originality of its articles with the evident conviction that *The Electrician* was created solely for the purpose of supplying its columns with information of a superior character to its own, would do well to emulate the example of Diogenes, with a view to filling up a possible future vacancy in the editorial department, or, at least, to remember that candour is a virtue possible even in newspaper offices. We have had occasion, more than once, to comment upon the moral obliquity of foreign journals, which have from time to time purloined our matter, with an utter disregard of the laws of *meum* and *tuum*, strongly suggestive of a defective moral training. We regret to see an English contemporary following in their footsteps. Were we given to reprisals, which we are not, we fail to discover any possible means of redress, save that of mild complaint. The old Mosaic rule is debarred us. In justice to our subscribers, our notes must be gathered from sources other than the antique.

YIELD OF BICHROMATE BATTERIES.—The results of the first experiments in domestic lighting by the battery of MM. Buchin, Tricoche et Cie, appear to the *Bulletin International des Téléphones* to confirm the favourable opinion formed of it by our contemporary, who says that, to maintain an incandescent lamp of eight volts, giving an intensity of three candles, it is sufficient to employ a 6-element No. 2 battery, of 65 by 63 mm. surface and 14 cm. high (2½ by 2⅜ by 5½ inches), containing one zinc and four carbon electrodes specially prepared. The first cost is about 25fr. (£1) for Swan lamp and battery; and the expense of maintenance is put as follows:—400 grammes (1lb.) of bichromate of potash at 1fr. 50c. (1s. 3d.) per kilogramme (2·2lb.), 60 centimes or 6d.; 500 grammes (1·1lb.) of sulphuric acid at 40 centimes (4d.) per kilogramme, 20 centimes (2d.); zinc, 50 centimes (5d.); total, 1fr. 30c., or a little over a shilling. After being charged, the battery is said to work for four hours uninterruptedly, so that the cost is 33 centimes, or about 3d. per hour of light. This type of battery will also work for eight hours consecutively with the same zincs, on changing the liquid after four hours action.

ELECTRICAL EFFECTS AT CHELMSFORD.—"Ampère" writes us that, though there is no dynamite outrage at Chelmsford, the "electric fluid in those parts is answerable for many strange effects." He encloses a sensational paragraph from *The Newsman*, entitled "Nocturnal Amusements at Chelmsford," to the effect that "the residents in the neighbourhood of Messrs. Crompton and Co.'s electric light works, Moulsham, were awakened about half-past 3 by the reports of crackers and other fireworks proceeding from the direction of Savernake Lodge, which is occupied by some of the pupils. The true cause of the alarm was, however, stated by "One of the Pupils," in a letter to the *Essex Chronicle*, containing the following explanation:—"Messrs. R. E. Crompton and Co. have lately received a large order for 'polarised galvanometric exploders,' the first lot of which were finished on Thursday. Unfortunately, they were left in the garden of Savernake Lodge 'in series' with a potential indicator, the ammeter of which ran hot in its bearings during the night, thus causing the series of explosions which so startled the good people in the neighbourhood. This accident affords an additional proof, if such were wanted, of the superiority of the suspended over the pivotted needle."

LIGHTING BY SIEMENS IN FRANCE.—The following are the principal establishments in France where Messrs. Siemens Brothers, Paris, have put down lighting plant, with the number of lamps:—A. and C. Berthélemy and Co., spinning mills, Signy l'Abbaye, 75; Blazy Frères, spinning mills, Yerres, 300; Compagnie Générale Transatlantique, steamer "Normandie," Havre, 390; Compagnie des Messageries Maritimes' steamer "Yarra," Marseilles, 184; L. and C. Crepy, spinning mills, Lille, 80; A. Deguerre, mechanical weaving, Maxonchamp, 100; Grandjean et Cie., St. Souplet, Nord, 60; Grands Moulins de Gray, 50; Isaac Holden and Son, wool combing, Croix, 100; E. Lacroix, boot and stay lace factory, Arcis-sur-Aube, 50; Lemaitre, Lavotte, et Cie., weaving works, Bolbec, 500; Schneider and Co., ironworks, Creusot, 160; Vicomte de Tocqueville, Tourlaville, 120; Vachon, Son, and Co., measure makers, Lyon, 160; Van de Weghe et Cie., mechanical weaving, Fives-Lille, 350; Veillage, Chamussy et Bourg, Amplepuis, 200; Vincent and Son, tanners, Nantes, 60. Besides the above, Messrs. Siemens have carried out 33 other lighting installations, bringing the number of lamps for 1884 up to 1,004, and the total number installed in France to 3,868.

ELECTRICAL ACCUMULATORS.—In a paper on this subject before the Société Belge d'Electriciens, M. René Tamine, Ingénieur des Ponts et Chaussées, concludes that a study of the secondary currents generated by the voltmeters of various metals permits (1) of establishing a methodical classification of accumulators, and (2) of practically realising the accumulator which possesses a maximum of electromotive force. When a voltmeter formed with lead, copper, iron, or zinc (leaving the precious metals out of the question) immersed in diluted sulphuric acid, be subjected to the action of a primary electric current, and the effects produced during the discharge, that is to say during the action of the secondary current, it is found that (*a*) the lead is the only one of the above-named metals which produces on the electrodes, under the influence of the charge or the discharge, an oxide insoluble in diluted sulphuric acid, and (*b*) the E.M.F. of the current depends especially, with copper, zinc, and iron, on the activity of oxidation of the spongy layer formed on the negative electrode during the charge. With the lead, on the contrary, the E.M.F. depends especially on the energy of reduction of the layer of oxide formed on the positive electrode under the influence of the primary current. The first of these conclusions supplies an explanation of the phenomenon of polarisation in lead accumulators.

MR. JAMES SIVEWRIGHT, C.M.G.—It is with considerable regret that we hear of the retirement of Mr. Sivewright from the direction of the Cape Government Telegraphs. During

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the years of his administration, by untiring industry and great knowledge and experience, he made the telegraph service of that colony a thoroughly efficient one. Under his direction the lines have been widely extended, and are in capital order. The staff of operators has been admirably trained, and we are informed that detentions and delays in the transmission of messages are of but rare occurrence. The reason for Mr. Sivewright's retirement is the amalgamation of the Telegraphs with the Post Office. Mr. Aitchison, the present Postmaster-General, is to have control of both the post office and telegraph departments; and Mr. French is to relieve Mr. Sivewright of his duties. The *Wynberg Times* says:—"In 1881 Mr. Sivewright gained the distinction of securing a revenue of 16½ per cent. on the total expenditure of his department, which, under his careful superintendonce and economical working, has become the most prosperous branch of the Public Service at the Cape. There have been so few men combining in one person so many excellent qualifications, that Mr. Sivewright may justly be considered a Colonial *rara avis*; and it is undoubtedly a matter of surprise to the general public that the cessation of his duties should ever have been mooted. The period of Mr. Sivewright's actual service in the colony is, we believe, eight years. His service, however, in this country should count in the calculation of the pension to which he is entitled, and which, in all probability, will amount to £480 per annum."

Orchorowicz Telephone.—In this instrument, which is stated by M. Hospitalier, in *L'Electricien*, to be the most powerful he has heard, the inventor has sought to transmit to a distance speech, as well as vocal and instrumental music, with such clearness that an opera—for instance—may be heard by several people some distance from one another, and without having to bring the receiver to their ears. The system comprises a microphonic transmitter of new and special construction, and of a magnetic receiving telephone, the magnet of which is a solid steel cylinder with a slot down the length of its surface 5 or 6 mm. (¼in.) wide, with two soft iron cores 3 or 4 mm. in diameter about the middle and carrying coils. The latter are enclosed in a kind of flat box, formed of two thin iron plates, one at the top opposite the cores (as in ordinary telephones) and the other at the bottom, screwed to the middle of the magnet. The lower plate is pierced with two holes of a larger diameter than the soft iron cores which traverse it, so as to move freely without touching, these two circular and parallel plates being connected together at their outer edges by a metal crown. In this way, the two plates are only fixed by a point, that which connects the lower plate with the magnet; they form a kind of vibrating box very mobile and elastic, which contains the coils. When the undulating current, modulated by the transmitter, passes through them, it modifies the flow of force inside, increasing or diminishing it. The box closed by the two plates contracts or expands under the influence of these variations of intensity, vibrating throughout its whole substance, thus accounting for the remarkable power of this telephone. It is also capable of acting as a magnetic transmitter, and permits of speaking and hearing in the same manner for a certain distance; but in this case the effect is considerably less marked than with the microphonic transmitter.

Thermodynamic Potential of Batteries.—The following is an abstract of a paper by M. P. Duhem, on "The Thermodynamic Potential and Theory of the Voltaic Battery," brought by M. Hermite before the French Academy of Science:—Simple lines of reasoning, founded on the views which M. Clausius has introduced into thermo-dynamics, show that the heat evolved in any isothermic modification whatever consists of two parts, one equivalent to the work compensated and the other to that which is not compensated. The latter is *nil* if the modification is reversible, but in the contrary case it is necessarily positive. Whence is easily deduced the theorem that "For a system to be in stable equilibrium, it suffices for all practically isothermic modification in that system to correspond with a *nil* or negative work not compensated," this theorem being explained by electrical phenomena. The thermo-dynamic potential of any electrified system, the various points of which are immovable, may be calculated by merely employing Coulomb's law, and that of Ampère for closed and uniform currents. The study of this potential gives in electrostatics the theory of the differences of potential, on the contact of two metals, of Peltier's phenomenon of electrical expansion, &c.; and, adding thereto Joule's law as to the heating of conductors, a complete theory of the voltaic battery, with this principal result, that chemical reaction in the couples would furnish, if the current be not utilised, a quantity Q of heat compensated, and a quantity Q^1 of heat not compensated. The following theorems are capable of absolute proof:—"The heat evolved in the battery in action equals $Q + Q^1$. Voltaic heat, that is to say, the quantity Ari^2, in which r represents the circuit resistance and i the current intensity, equals the heat Q^1, which is not compensated. The excess of chemical heat over the voltaic value is therefore equal to the positive or negative quantity Q." In this manner may be entirely explained the disaccord, pointed out by Favre, between chemical and voltaic heat.

Electrical Transmission of Power.—M. Cornu has reported on the experiments made on 4th March, 1883, at the works of the French Northern Railway, as to the application of M. Deprez' dynamos to the transmission of power along a telegraph wire. The generating machine (a Deprez No. 20) was connected with the receiver (a D Gramme machine transformed) on one side by a short wire of but little resistance, and on the other by a 4mm. galvanised iron telegraph wire, 17 kilometres = 10½ miles long, passing through the Bourget station. These conditions, although not identical with those which are usual in the electrical transmission of power, did not appear to the commission sufficient to detract from the value of the experiments, as continuous and not alternating currents were employed. The results of the measurements are of two kinds—dynamometric, relating to the power transmitted; and electric, relating to the electromotive force developed in the generating and receiving machines. The following are the principal conclusions deduced from the tables of dynamometric and electrical results which were obtained:—"The work absorbed by the generating and transmitted to the receiving machine increased with the speed of the generator, attaining 4½ horse-power for a speed of 1,024 revolutions, against an effective resistance of 160 ohms, representing a double telegraph line 8½ kilometres, or 5 miles long. The gross yield amounted to as much as 37½ per cent. of the work expended; and, if the mechanical motor be allowed for, so as to arrive at the result produced by the successive transformations of energy, the dynamometric result even reached 48 per cent. The table of electrical results shows that the telegraph line practically offered, while the power was being transmitted, that is to say with a current of 2½ amperes, the resistance of 160 ohms which was recorded with a current of 0·01 ampere during the former experiments. This observation appears to sufficiently establish the agreement of theory and practice so far as concerns an analysis of the phenomena of transformation of energy in the circuit."

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ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 221.)

Second Connection between Electric Force and Magnetic Force.

The equation (15), curl $H = 4\pi\Gamma$, expressing a relation, independent of physical constants, between the magnetic force and the electric current, is an extension of Ampère's results for linear circuits. By Γ must be understood Maxwell's true current—that is, the sum of the conduction current and the displacement current if the body considered be both a dielectric and a conductor, or the conduction current alone or the displacement current alone if the body have no dielectric capacity or no conductivity respectively. All bodies are either conducting or dielectric, or both, and ether is dielectric, so that electric current may exist everywhere. Putting Γ in terms of E by the equation of true current (8), p. 149, where $c\mathrm{E}$ should be $c\dot{\mathrm{E}}$, we get

$$\text{curl } \mathrm{H} = 4\pi k\mathrm{E} + c\dot{\mathrm{E}}, \quad . \quad . \quad . \quad . \quad (19),$$

which is one connection between E and H.

The second connection may be obtained by translating Faraday's law of induced electric force in a linear circuit into a mathematical form. It is remarkable that the ideas of Faraday, who was no mathematician, should admit of immediate translation into mathematical language; a fact due to his dispensing with the direct action at a distance hypothesis, and employing the intermediate mechanism of lines or tubes of force. In popular language, the total E.M.F. of induction round a linear circuit is measured by the number of lines of force taken out of the circuit per second. Here the conventional connection between the assumed positive direction of translation through a circuit, and the assumed positive direction of motion in the circuit must be remembered. Selecting either direction through a circuit as the positive direction of translation, look through the circuit in this direction. Then the positive direction of rotation is right-handed, or with the hands of a watch whose front faces the spectator. Thus, increasing the number of lines of force through a circuit sets up negative E.M.F. round it.

So far in a medium of unit permeability. But when we make allowances for differences in "conductivity for lines of force," that is differences of magnetic permeability, it is not the variation of the magnetic force H, but of the magnetic induction $\mathrm{B} = \mu\mathrm{H}$, which determines the induced E.M.F. The amended statement is that the total E.M.F. of induction round a circuit equals the rate of decrease of the amount of magnetic induction through the circuit. Now, since we have here a line-integral, viz., of the electric force of induction round a circuit, and a surface-integral, viz., of $-\mu\dot{\mathrm{H}}$ or $-\dot{\mathrm{B}}$ over any surface bounded by the circuit, we may at once apply the Version Theorem before referred to (p. 219) and deduce

$$\text{curl } \mathrm{E} = -\dot{\mathrm{B}} = -\mu\dot{\mathrm{H}}, \quad . \quad . \quad . \quad . \quad (20),$$

which of one form of the second relation between E and H.

The following method is also instructive. Since the rate of increase of the magnetic induction at a point equals $4\pi\mathrm{G}$, where G is the magnetic current, as defined by equation (12), we may state the law of induced electric force thus. The total E.M.F. of induction round a circuit in the negative direction equals 4π times the total magnetic current through the circuit in the positive direction. Now compare this statement with the statement regarding equation (15) on p. 220, viz., that the total magnetic force round a circuit equals 4π times the total electric current through the circuit, and change this so as to produce the statement in the last sentence. We must change magnetic force to electric force taken negatively, and electric current to magnetic current. Hence

$$\text{curl } \mathrm{H} = 4\pi\Gamma, \quad . \quad . \quad . \quad . \quad (15)\ bis,$$

becomes

$$-\text{curl } \mathrm{E} = 4\pi\mathrm{G}, \quad . \quad . \quad . \quad . \quad (21),$$

which is equivalent to (20).

We have, in order to simplify the establishment of (20) or (21), avoided mentioning the E.M.F. induced in a linear circuit by its motion in the field, which may or may not be varying independently. The amount of induction added to or taken out of a circuit from this cause may be obviously represented by a line-integral, as it depends upon the rate at which the different elements of the circuit cross the lines of induction. If the induction were of the same strength at all the moving parts of the circuit, and they all moved at right angles to their lengths and also perpendicularly across the lines of induction in the same sense, the total E.M.F. would be of strength = B × rate of increase of area of circuit. But when B varies, and likewise the velocity of the different elements across the lines of B, each element must be considered separately. The amount contributed to the total E.M.F. by an element of unit length equals the component parallel to its length of $V v\mathrm{B}$, if v be the vector velocity. But, if there be current induced, this brings in working mechanical forces, and should therefore be separately considered. At present we return to the case of c, k, and μ constant with respect to the time, and no parts moveable.

In equation (21), E is the E.M.F. of induction only, not the actual E.M.F. There may be in addition electrostatic force, and also impressed electric force. But the electrostatic force is polar; it is derived from a scalar potential. If this be P, the force is $-\nabla\mathrm{P}$. But curl $\nabla\mathrm{P} = 0$, as was before remarked on p. 220 with reference to Ω, consequently the polar force may be included in E in equation (21). Similarly any polar force may be included in H in the previous equation (15). Now in all our equations, from (1) up to (14), not containing any relations between E and H, those symbols mean the actual resultant electric and magnetic force from all causes. Hence, in order that the two equations (15) and (21) may harmonise with the preliminary equations (1) to (14), not only in space when there is no impressed force, but at the places where such exist as well, we must, whilst still using E and H to denote the actual forces, deduct from them the impressed forces in using the relations (15) and (21). So, let e be the impressed electric force, and h the impressed magnetic force. Our two connections between E and H are then

$$\text{curl } (\mathrm{H} - h) = 4\pi\Gamma = 4\pi k\mathrm{E} + c\dot{\mathrm{E}}, \quad . \quad . \quad (22),$$

$$\text{curl } (e - \mathrm{E}) = 4\pi\mathrm{G} = 4\pi g\mathrm{H} + \mu\dot{\mathrm{H}}, \quad . \quad . \quad (23),$$

where the coefficient g of magnetic conductivity is introduced to show the symmetry, and may be put = 0. We have now a dynamically complete system.

The subject of impressed force will be considered in a following section more fully, especially as regards impressed magnetic force, and its interpretation in terms of magnetisation. In the meantime we may define impressed electric force thus. If e be the impressed electric force at a point, and Γ the electric current there, $e\Gamma$ of energy is taken into the electro-magnetic system there per unit volume per second. Similarly, we may define the impressed magnetic force h at a point, by saying that if there be a magnetic current G there, $h\mathrm{G}$ of energy is taken in per second per unit volume by the electromagnetic system there. In general, $e\Gamma$ and $h\mathrm{G}$ are scalar products (*see* equation (5)), having the ordinary signification when e is parallel to Γ, or h to G, in other cases to be multiplied by the cosine of the angle between e and Γ or between h and G.

The Equation of Energy and its Transfer.

We must find the rate of working of the impressed forces, and compare with the dissipativity and with the changes taking place in the energy of displacement and the magnetic energy. Multiply (22) by $(e - \mathrm{E})$ and (23) by $(h - \mathrm{H})$, and add the results. We get

$$4\pi\{(e - \mathrm{E})\Gamma + (h - \mathrm{H})\mathrm{G}\} = (e - \mathrm{E})\,\text{curl}\,(h - \mathrm{H}) + (h - \mathrm{H})\,\text{curl}\,(e - \mathrm{E}).$$

Or

$$e\Gamma + h\mathrm{G} = \mathrm{E}\Gamma + \mathrm{HG} + \frac{1}{4\pi}\{(\mathrm{H} - h)\,\text{curl}\,(\mathrm{E} - e) - (\mathrm{E} - e)\,\text{curl}\,(\mathrm{H} - h)\} \quad (24),$$

by rearrangement. $\mathrm{E}\Gamma$ and HG here occurring have been already expressed in terms of the dissipativity Q, the electric energy of displacement U, and the magnetic energy T; *see* equations (9) and (14). Thus

$$\mathrm{E}\Gamma + \mathrm{HG} = \mathrm{Q} + \dot{\mathrm{U}} + \dot{\mathrm{T}} \quad . \quad . \quad . \quad . \quad . \quad (25).$$

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On the left side we have the rate of working per unit volume of the actual forces E and H on the currents Γ and G; on the right side the dissipativity, or rate at which energy is being lost from the system irreversibly, producing heat according to Joule's law, and the rate of increase of the electric and magnetic energies, all per unit volume.

Now looking at (24), the left side expresses the rate at which energy is being taken in (reversibly) per unit volume, in virtue of the impressed forces e and h. Therefore the excess of $(e\Gamma + hG)$ over $(E\Gamma + HG)$ must be the energy leaving the unit volume per second through its sides. Now, X and Y being any two vectors,

$$Y \operatorname{curl} X - X \operatorname{curl} Y = \operatorname{div} VXY, \quad . \quad . \quad . \quad (26),$$

or in full, by (5), (16), (17), and (3),

$$Y_1\left(\frac{dX_3}{dy} - \frac{dX_2}{dz}\right) + Y_2\left(\frac{dX_1}{dz} - \frac{dX_3}{dx}\right) + Y_3\left(\frac{dX_2}{dx} - \frac{dX_1}{dy}\right)$$
$$- X_1\left(\frac{dY_3}{dy} - \frac{dY_2}{dz}\right) - X_2\left(\frac{dY_1}{dz} - \frac{dY_3}{dx}\right) - X_3\left(\frac{dY_2}{dx} - \frac{dY_1}{dy}\right)$$
$$= \frac{d}{dx}(X_2Y_3 - X_3Y_2) + \frac{d}{dy}(X_3Y_1 - X_1Y_3) + \frac{d}{dz}(X_1Y_2 - Y_1X_2);$$

using the numbers 1, 2, 3, to denote the x, y, and z components. Let then

$$W = \frac{1}{4\pi} V(E - e)(H - h) \quad . \quad . \quad . \quad . \quad (27);$$

then by (26), with $X = E - e$ and $Y = H - h$, equation (24) becomes

$$\left.\begin{aligned} e\Gamma + hG &= E\Gamma + HG + \operatorname{div} W \\ &= Q + \dot{U} + \dot{T} + \operatorname{div} W \end{aligned}\right\} \quad . \quad . \quad . \quad (28),$$

the equation of energy put in its most significant form. Summing up through all space, W goes out; the total work per second of the impressed forces equals the total dissipativity plus the rate of increase of the total electric and magnetic energy.

W is the vector rate of transfer of energy, or what we before (p. 179) termed the energy current, a vector whose direction is that of the transfer of energy, and whose magnitude equals the amount transferred per second across unit area of a plane perpendicular to that of transfer. Note on p. 179 that impressed forces were said to be not counted; hence as E and H are the actual forces now, the impressed forces are deducted, as shown in (27). The magnitude of W is the product of the strengths of the two forces and the sine of the angle between their directions, and the direction of W is perpendicular to both forces, with the before-stated convention regarding positive directions.

The general nature of the energy current was described in the section "On the transmission of energy through wires by the electric current," p. 178, where, however, only impressed electric force was considered. The same general results apply to impressed magnetic force; energy proceeding from places where such exists, to be dissipated as heat in conducting matter, or to increase the electric and magnetic energies, or to go to other places of impressed magnetic force. But there are great practical differences between impressed electric and magnetic force, owing to the transient nature of magnetic currents and other causes.

Differential Equations of E *and* H.

By eliminating E or H between (22) and (23) we obtain the characteristic equation of E or of H. Put $g = 0$, and eliminate H. Then,

$$\operatorname{curl} \mu^{-1} \operatorname{curl} (e - E) = \operatorname{curl} \dot{h} + 4\pi k\dot{E} + c\ddot{E}, \quad . \quad (29),$$

which is the equation of E. Here e and h, being impressed, must be supposed to be given. μ^{-1} is the operator inverse to μ, that is, in the general case of eolotropy μ^{-1} is defined by the three principal axes and the values $\frac{1}{\mu_1}, \frac{1}{\mu_2}, \frac{1}{\mu_3}$, along them, as was explained on p. 149 in speaking of k. Similar remarks apply to k^{-1} and c^{-1} should they occur.

In space where there is no impressed electric force, and no, or else constant, impressed magnetic force,

$$\operatorname{curl} \mu^{-1} \operatorname{curl} E + 4\pi k\dot{E} + c\ddot{E} = 0. \quad . \quad . \quad (30)$$

In a non-dielectric conductor,

$$\left.\begin{aligned} &\operatorname{curl} \mu^{-1} \operatorname{curl} E + 4\pi k\dot{E} = 0 \\ \text{and,} \quad &\operatorname{curl} k^{-1} \operatorname{curl} H + 4\pi\mu\dot{H} = 0 \end{aligned}\right\} \quad . \quad . \quad . \quad (31)$$

Here propagation of E and of H is by diffusion. And in a non-conducting dielectric

$$\left.\begin{aligned} &\operatorname{curl} \mu^{-1} \operatorname{curl} E + c\ddot{E} = 0 \\ &\operatorname{curl} c^{-1} \operatorname{curl} H + \mu\dot{H} = 0 \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (32)$$

Here propagation is by waves, *i.e.*, propagation of E or H, not of energy.

c and μ self-conjugate; k not necessarily so.

We should note that

$$\dot{T} = \frac{d}{dt}\left(\frac{1}{8\pi} H\mu H\right) = \frac{1}{8\pi} H\mu\dot{H} + \frac{1}{8\pi} \dot{H}\mu H,$$

whilst

$$HG = H\frac{\mu\dot{H}}{4\pi};$$

so for HG to equal $\dot{T}$ we require $H\mu\dot{H} = \dot{H}\mu H$, *i.e.*, μ must be self-conjugate, or contain no rotatory ϵ (equation (3), p. 149). Similarly, for $\dot{U}$ to equal $E\dot{D}$, c must be self-conjugate. But there is no such limitation thrown upon k the electric conductivity operator, nor would there be upon g the magnetic conductivity operator, did such exist. There are other proofs of these conclusions, but the above are very short. There is, however, an objection to be raised against the rotatory conductivity vector ϵ, which want of space does not permit to be mentioned at present.

(TO BE CONTINUED.)

ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 259.)

This last experiment leads us to the conception that every medium offers a certain resistance to the passage of lines of force, and the inverse of that resistance is called the magnetic permeability of the medium. According to Professor Thompson ("Dynamo-Electric Machinery," p. 38) the permeability of iron is from forty times to 20,000 times as great as that of air. In other words, if we were to surround our straight wire by a cylinder of iron the current would yield within that space from forty to 20,000 times as many lines as if the space contained air. The figures given by Professor Thompson of forty and 20,000 are so widely different that one is inclined to doubt whether anything like a fixed ratio for the permeability of iron and air exists, or can easily be found by experiment. To make such experiment of use for the builder of dynamos it ought not to be undertaken on a small laboratory scale, but with real dynamos. This the author has attempted to do, as will be shown further on, and as an average result he found that wrought iron offers about $\frac{1}{150}$ to $\frac{1}{200}$ of the resistance of air. Cast iron has a considerably higher resistance; generally speaking it requires from 2 to $2\frac{1}{2}$ times the exciting power to get the same number of lines through a piece of cast iron than through an equal piece of wrought iron. In giving these figures the author would point out that he does not consider them as final, but merely as a first attempt to get at something like a tangible result until others succeed in obtaining more exact figures. Experiments of that nature are very difficult, especially on account of the leak of lines through air outside of the dynamo, and also on account of the uncertainty which exists in estimating the degree of saturation. But to return to our straight wire traversed by a current and our small magnet placed near it, somewhere about the middle of its length. Experiment shows that not only that portion of the wire which is immediately close to the magnet affects it, but also the portion above and below, and if we retain our conception that no part of the current can act on the magnet except by a line of force which must actually go through it, we are forced to the conclusion that the lines must be closed curves of three dimensions, that is curves in space. Let in the annexed sketch $w\ w$ be the wire, which for our purpose we can assume to be

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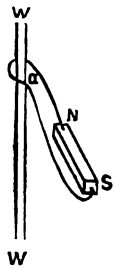
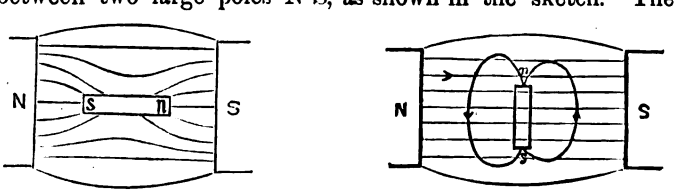
infinitely long, then a line corresponding to the current in point *a* must bend downwards, as shown. We can now consider the upper part of the line to lie in a plane at right angles to the wire, and the lower part in a plane more or less inclined to the former. With a straight wire infinitely long the angle of inclination varies between 0 and 90 degrees, but from the experimental fact that a current cannot exert any influence on a magnet pole situated in a straight line with the current, it follows that 90 degrees is the limit through which a line of force can be deflected, and if so deflected its influence is already infinitesimal. The importance of this fact will be seen later on when we come to consider which parts of the winding on the field-magnets are useful and which are useless wire.



The nearer the magnet is to the wire the greater is the force which tends to set the magnet at right angles to the wire. To explain this we can either assume that the force exerted by each individual line is the same, but that more lines are pulling at the magnet when the latter is close to the current, or we can assume that the same number of lines pass through the magnet whatever its position, but that each individual line is the stronger the more closely it encircles the wire. Either conception leads to the same thing in the end, but the latter has the advantage of being more easily applicable to complicated cases. We can put it also in this way:—The shorter the total length of a line of force and the greater that proportion of it which goes through iron, the stronger will the line be. From the fact that magnet poles of the same sign repel each other we conclude that parallel lines running in the same sense repel each other. This follows also from the experiment by which the lines round the wires are made visible; for if the inner lines were not to repel the outer ones the latter would not be found at so great a distance from the wire. The attraction of magnet poles of opposite sign points to another quality of the lines of force, viz., that each line tends to shorten itself; and this is also the reason why the lines round a free wire are concentric circles. The circle is of all curves possible the shortest for a given diameter. Each line has a tendency to tighten itself up into the smallest possible circle, but this tendency is opposed by the repulsion from neighbouring lines within the circle, whilst lines without it assist the tendency. Each line, therefore, takes up a certain position of equilibrium where its own force of contraction is exactly balanced by the repulsion from the other lines.

When lines cross each other at an angle they tend to become parallel, but of opposite sense, and thus to eliminate each other. This can easily be proved by placing a small magnet between two large poles N S, as shown in the sketch. The



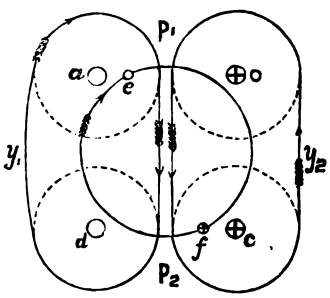
magnet will turn on its centre until *s* points to N and *n* to S, when the lines originally belonging to it will have vanished, being eliminated by the lines between the large poles.

The above remarks are a kind of list of some of the properties of magnetic lines of force. It will be useful to briefly sum them up.

1. A line must be a closed curve. 2. It has a tendency to shorten itself, becoming the stronger the shorter it is. 3. It need not be a plane curve, and part of it can be bent off at any angle short of 90 degrees. 4. It finds less resistance in iron than in air, and a greater number of lines can run through iron than through an equal space of air. 5. Parallel lines of the same sense repel each other, and parallel lines of opposite sense attract and eliminate each other. 6. Lines crossing at an angle have a tendency to set themselves parallel, but in opposite sense.

It is well known that if a closed wire is moved so as to cut lines of force a current flows in it as long as the movement lasts. Suppose we have a straight wire traversed by a current, and we approach to it another straight and parallel wire forming part of a closed circuit, then the current induced in the latter will be in opposite direction to that in the fixed wire, and if we remove the wire the current will be in the same direction. What the reason of this phenomenon is we cannot say, and it will probably remain as much a mystery as the invisible cause of the force of gravitation; but for our purpose it suffices that we know this effect does take place and can be utilised.

Imagine that, instead of having only one fixed wire, we place for such wires *a b c d* round a circle (Fig. 1), the wires being perpendicular to the plane of the paper. Let the current go from the observer in *a* and *d*, and towards the observer in *b* and *c*. To make the drawings plain in this and all the following diagrams, a current directed downwards is denoted by a dot in the centre of the little circle representing the wire, and a current directed upwards by a cross. The lines of force, of which for the sake of clearness only one is shown to each wire, will, according to the assumption made in the previous article, run round *a* and *d*, in the direction of the hands of a watch, and round *b* and *c* in opposite direction. The lines round each wire would be complete circles if no other wires were near; but through the influence of other wires their shape is altered. Thus, where the lines belonging to *a* and *d* come near each other they are in opposite sense; they attract and eliminate each other. The same happens on the other side between *b* and *c*, and to make this clear in the drawing those portions of the lines which have been mutually eliminated are dotted, the rest being shown in full.



Now, let a movable wire revolve in the direction of the arrow between the four fixed wires. Whilst passing from *a* to *b* this wire cuts a number of lines belonging to these two fixed wires. Since the lines are most dense close to *a* and less so towards the middle between *a* and *b*, the wire *e* cuts lines at a decreasing rate in receding from *a* until the middle is reached, and from there towards *b* again at an increasing rate as it approaches this wire. In receding from *a* the current in *e* must be in the same direction, viz., downwards, and in approaching *b* it must be in opposite direction to that in *b*, therefore also downwards. We see that although the rate of cutting of lines between *a* and *b* is variable the general effect is to produce a current downwards. Between *b* and *c* no lines are cut if we suppose that all the lines have been mutually eliminated, but between *c* and *d* lines are again cut. The wire in receding from *c* has induced in it an upward current, and the same effect takes place in approaching *d*. We can now establish a rule for the direction in which a current will be induced by the cutting of lines of force. *Imagine a man substituted for the wire and his face turned so that the lines run towards him (which is equivalent to looking towards a N pole), then if he move laterally to the left the current will flow from his feet to his head. If he move laterally to the right the current will flow from his head to his feet.*

If, instead of having only one wire, we have two diametrically opposite, *e* and *f*, and join them at one end by a cross connection, we could arrange at the other ends rubbing contacts between the points *a b* and *c d*, by which the current induced in the two wires could be taken off. We should then have an intermittent current, but always in the same direction. Suppose that instead of only two wires we have a great number all round the circumference, and join them up in the manner of a Hefner-Alteneck armature and commutator, the current would be continuous. It will of course be clear that the apparatus here described would make but a very poor machine for the generation of electric currents; from a scientific point of view it is, however, interesting to see how the simple phenomenon of induced currents between two wires could be turned to account for producing continuous currents without the aid of any iron or permanent magnets. The effect of the machine, even if a very strong current from an independent source were sent through the fixed wires, would

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be very feeble; but assume that instead of only one wire in each of the four corners we were to have several, joining them up into a coil between a and b and between c and d; and assume also that, in order to reduce the magnetic resistance, we were to put soft iron into the path of the external lines of force, joining $P_1 Y_1 P_2 Y_2$ by an iron framework, we should thus arrive at the usual form of a dynamo with pole pieces $P_1 P_2$ and yokes $Y_1 Y_2$, and the current produced would be very strong.

(TO BE CONTINUED.)

THE MOST ECONOMIC POTENTIAL DIFFERENCE TO EMPLOY WITH INCANDESCENT LAMPS.

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

As stated by Mr. Gordon in your issue for the 7th inst., and as stated by others over and over again, a mere list of efficiencies of incandescent lamps without any tests of the life of the lamps at the various candle-powers is at the present time nearly useless.

The experiments made by Sir William Thomson, and by ourselves, in 1880, in the earlier days of incandescent lamps, on the number of candles per horse-power given by the various types of lamps for various potential differences maintained at their terminals, were interesting enough in leading to the law of the rapid increase of the light emitted relatively to the power expended electrically on the lamps. But such experiments by themselves cannot possibly enable us to decide on the commercial value of any particular incandescent lamp, and therefore their repetition *alone* over and over again, by various experimenters since 1880 for incandescent lamps, has added but very little to our knowledge.

A striking exception must however, of course, be made to this statement in reference to the splendid series of experiments made by Captain Abney and Lieut.-Colonel Festing, since, although these experiments have been made without reference to the life of the lamps, they were made for the object of determining, among other things, the simultaneous efficiency for different parts of the spectrum, and therefore have great value in helping us to judge how far it may be possible to use an incandescent lamp as a standard of white light.

In your issue for January the 31st a table of values of the life of a 100 volt Edison lamp for different potential differences is given by Mr. Foussat. Objection has been taken to these results by Mr. Massey, in your issue for the 14th inst., because the points lie very regularly in a curve; but if it be remembered that the results are stated to be the *average* of a very extended series of tests, and that it is quite possible that Mr. Foussat may have employed the perfectly legitimate process of correcting his results by the most probable curve connecting them, it is not quite certain that this great regularity is necessarily a proof of inaccuracy. Some days ago we applied to Mr. Foussat, asking him whether he had also the results of experiments on the efficiency of the same type of 100 volt lamps, as our own experiments on the efficiency of Edison lamps had been made with 55, 108, and 110 volt lamps. As, however, he had not such results, and as his tests of the lives are the only ones that we now have, and very possibly will have until the completion of the excellent work at present being carried out by the Electric Lighting Jury of the Health Exhibition, we must endeavour to combine his results of life with results previously published for efficiency. To enable us to do this we will assume that the life of 1,000 hours given by Mr. Foussat for his 100 volt lamp when used with a potential difference of 100 volts would be the same as that for our 108 volt lamp when employed with a potential difference of 108 volts, or, in other words, we may regard lives given by him as correct for 108 volt Edison lamps when each potential difference is multiplied by $\frac{108}{100}$.

To ascertain the most economic potential difference we must proceed as follows: Let $f(v)$ be the function connecting life in hours with the number of volts constantly kept on the lamp, $\theta(v)$ the function connecting the number of candles emitted by one lamp with the potential difference in volts employed, let p be the price in pounds paid to buy one lamp, and n the number of hours per year that a lamp is kept burning, then

$$\frac{p \times n}{f(v) \times \theta(v)}$$

stands for the cost per year, per candle, as far as the purchase of lamps is concerned.

Next let H stand for the cost in pounds of an electric horse-power per year for the number of hours electric power is employed. H will not, as mistakenly supposed in the Electric Lighting Act, be proportional to the number of hours, but will be of the form of $h + F(n)$, where h is a constant independent of the number of hours, and depending on the rent of the site, capital expended in engines, dynamos, leads, &c.; and $F(n)$ is a function of the number of hours that electric power is required, and depends on the cost of coal, superintendence, &c. If the light were only required for one or two hours in a district where rent was very high, h would be the all important term, and $F(n)$ would be unimportant; whereas, if the electric power were required for various purposes for, say, 15 or 20 hours out of the 24, in a place where rent was low but coal dear $F(n)$ would be the important item in the yearly bill for electric power supplied. Let $\phi(v)$ be the function connecting watts used per candle with the number of volts employed at the terminals of a lamp, then

$$\frac{H}{746} \times \phi(v)$$

stands for the cost per year, per candle, as far as the production of electric power is concerned.

The total cost, therefore, per year, per candle, is

$$\frac{p \times n}{f(v) \times \theta(v)} + \frac{H}{746} \phi(v) \text{ pounds} \quad . \quad . \quad A$$

and we must find the value of v that makes this a minimum.

There are two ways in which such a problem can be solved, the one a graphical method, the other an analytical method; and as the former is especially suitable for students, we will give that one first. This consists in drawing three curves to represent, 1st, $f(v)$ in terms of v; 2nd, $\theta(v)$ in terms of v; and, 3rd, $\phi(v)$ in terms of v. From these curves the values of $f(v)$, $\theta(v)$, and $\phi(v)$ are determined graphically for some one value of v, and from them the value of the above expression, A, calculated for this value of v. The values of $f(v)$, $\theta(v)$, and $\phi(v)$ are next determined from the three curves, all for one value of v, but differing from the value of v previously selected, and again the value of the above expression, A, is calculated. After this has been done for several values of v a fourth curve is drawn connecting the various values of the expression A with the corresponding values of v, and then, by inspection, it is easy to see for what value of v the expression A has a minimum value.

The following is the result so obtained for the 108 volt Edison lamps burning in the Finsbury Technical College:—

p is taken as five shillings, or £0·25;

n as 560 hours the time per year the lamps are lighted approximately;

H as £5, which, considering that the cost of the steam engine, price of coal burnt, wages of the engine driver and stoker at the college have to be mainly debited to the driving of the workshops, supplying power for dynamos worked for experimental purposes, &c., amply covers, per horse-power, the yearly interest on what may be called extra plant and the extra cost of supplying electric power for lighting during the 560 hours per year.

Then the value of v, which makes A a minimum, turns out to be about 106 volts, and on account of the flatness of the curve connecting the expression A with v we see that in this particular case the annual cost of supplying light is only increased by 3·5 per cent. if the potential difference between the mains if kept diminished to about 104.8, or kept increased up to about 108 volts. Also that keeping the potential difference diminished to about 104·5 or increased to about 108·5 volts increases our total annual cost of lighting by 5 p.c.

In your next issue we will give some other results obtained graphically, as well as the details of the method of solving this problem analytically which we have employed.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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THE DISTRIBUTION OF ELECTRICITY.

Electrical engineers have had their attention of late fixed upon overcoming the difficulties attending the distribution of electricity over large areas far more than upon any other problem connected with electric lighting operations. Professor Forbes in his recent Cantor lectures has dealt very fully with the whole subject, and has suggested directions in which to work. The conclusion at which he has arrived—and in this conclusion he is supported by Dr. Fleming and others who have paid considerable attention to the subject—is that the future of electric lighting depends to a considerable extent upon the ability of electric light engineers to solve the problems which surround the transmission of electricity of very high E.M.F. Professor Forbes maintains that, with due regard to insulation, to the position of the mains, and in other directions which need not be discussed in detail, there should be absolutely no more danger from the use of electricity of high E.M.F. than from the so-called low pressure electricity as now permitted. This conclusion is probably correct, as it is difficult to see where the danger would arise in a well designed system, inasmuch as the E.M.F. at the point of utilisation—that is, at the terminal of the distributors entering the house—would simply be that required by the lamp used, which at the present time is not more than 120 volts. Although it is easy to point out that the use of electricity of high E.M.F. is very much more economical than the use of electricity requiring large conductors, we are not yet in a position either to insulate or to determine the best method of carrying our conductors. At the recent Philadelphia Exhibition a large number of systems for the carrying of conductors underground was shown. A tolerably full description of these various systems has just been issued by the examiners and published by the Franklin Institute. The full report is very lengthy, and but little information is to be gained from the comments of the examiners; in fact, we are left very much to draw our own conclusions as to the best system after having compared the descriptions. No tests were carried out by them owing to want of time and absence of facilities; therefore we have still to wait for such tests to ascertain the real value of any of the systems, except in such cases as have already been carried out upon a practical scale. Of these the Edison and the Brooke systems are the chief examples. The system which has had the most extended trial is that of Mr. Edison, and, as will be seen by a reference to Dr. Fleming's paper, a great many difficulties have been encountered and overcome; but it is allowed that, were a new system of mains to be adopted they would be laid on a different plan.

It must be remembered also, in considering the report of the Philadelphia Exhibition, that the examiners were not called upon to determine solely the value of underground systems for lighting purposes, but for the transmission of electricity generally. In the preface to their report this is distinctly put, as will be seen from the following paragraphs, the last of which is specially valuable as showing our ignorance of the subject:—

"Although the examiners abstained as far as possible from entering into the comparative merits of the systems, the examiners considered it advisable to note the obvious merits and demerits of each system, so far as they had means of judging. The points upon which they have commented are such as a sufficient experience of analogous contrivances enabled them to judge of from the bare statements and descriptions. In no case was it possible to state from actual observation of the working of any of these systems that they did or did not fulfil what was claimed for them.

"Your examiners are of the opinion that during the experimental stage of underground conduit construction for electric currents it is desirable, in the interest of the community in which such conduits are laid, that the latter be capable of use for as many different purposes and by as many different companies as possible; and also be capable of inspection in every part, and removal or replacement with the greatest possible rapidity and the least possible obstruction to the public highways.

"The rapid advance of electrical science in the past renders it nearly certain that the next few years will witness great changes in the methods for the production and distribution of this form of energy; and with an unelastic system in which a corporation may have expended large sums of money the practical advantages of the introduction of electricity may be entirely dissipated for a long time. For the same reason it seems to the undersigned unadvisable at the present time for a corporation to adopt any style of plant which is adapted only to one system of distribution, however excellent the system may seem to be.

"They feel impelled to add one final word in view of the doubt that has been expressed as to the feasibility of constructing underground conduits for all purposes of electrical distribution. Certainly—at least, within the limits of large cities—whether or not it be found in the future to be desirable to enclose telephone and telegraph with light and power circuits, or any two of the foregoing in the same conduit, they express no opinion; but that the electric current for any and all of these purposes can be successfully transmitted underground there is not the least reason to question.

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"They believe that a careful series of tests, made by competent experts on the systems already laid, would be of great value to science, and to all those who are interested in the use of the electric current."

We commend the information lately to hand concerning the distribution of electricity to those active and enterprising men who desire a change in the Electric Light Act. The alterations in this Act will depend very much upon the ability to show, not that installations of towns with ten, twenty, or a hundred thousand lamps have been rendered impossible, but that installations of one or two thousand lamps have been hindered by its clauses. The lighting of the Healtheries has been cited in proof of what can be done; but we consider it no proof at all. The conditions that hold at South Kensington are altogether different from those that hold in ordinary commercial transactions. The installation at Paddington will be watched with great interest, as it is really the second step in our experimental investigation of lighting on a fairly large scale, that at Holborn-viaduct being the first. There is one purely commercial question which should not in the present condition of things be overlooked. The putting down of a large installation, say 30,000 or 60,000 lamps, is even, after the Edisonian experience, a step in the dark. Ten years hence the capital required will be far less than at present, and investors of that period will have no sympathy with the pioneers who believed in the capabilities of existing systems. Then the pioneer companies will be overweighted with a capital account, and will see younger companies paying dividends due entirely to the experience gained by the operations of the pioneers. It is far better and far safer, from the commercial point of view, to go onward by gentle steps, from 500 to 1,000, from 1,000 to 2,000, than to attempt too large a task. Scientifically we have no doubt as to the ability to supply 50,000 or 100,000 lamps, but we are bound to work cautiously and protect ourselves from another wave of speculation.

CORRESPONDENCE.

LIFE OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With a view to obtaining the relations between the life of an incandescent lamp and the number of volts used, a question of so much importance as regards economy, I plotted out the numbers given in your issue of the 31st ult. as the results of experiments made at the Edison factory, Paris.

Taking the volts as abscissæ, and the hours as ordinates, the eleven resulting points were seen to lie well in a curve, and the curve on examination proved to be the logarithmic curve.

Let L = the life of the lamp in hours.
V = number of volts used.
L_0 V_0 = corresponding particular values of L, V;
we shall have

$$V_0 - V = k \log \frac{L}{L_0},$$

where k is some constant to be determined; V_0 and L_0 are together equivalent to one constant.

To find k from the present series of values, we have

$$V_0 - 95 = k \log 3595 - k \log L_0$$
$$V_0 - 96 = k \log 2751 - k \log L_0;$$

hence, by subtraction

$$1 = k (\log 3595 - \log 2751),$$
$$\therefore k = \frac{1}{\log 3595 - \log 2751} = 8{\cdot}60523.$$

Calculating in this way the values of k for the ten differences which we get between successive pairs of values of L, we find for the mean value $k = 9{\cdot}098213$, and the equation becomes

$$V_0 - V = 9{\cdot}098213 \log \frac{L}{L_0},$$

or giving to L_0 and V_0 the *normal* values of L and V, *i.e.*, 1,000 hours and 100 volts, we have

$$100 - V = 9{\cdot}098213 \log \frac{L}{1000}.$$

In the following table the values of L as deduced from this equation are compared with the values obtained by experiment:—

No. of volts.	Values of L obtained		Deviation.	Percentage deviation.
	From equation.	From experiment.		
95	3544·5	3595	+40·5	1·4
96	2752·0	2751	− 1	− ·04
97	2136·6	2135	− 1·6	− ·08
98	1658·9	1645	−13·9	− ·8
99	1287·9	1277	−10·9	− ·8
100	—	—	—	—
101	776·4	785	+ 8·6	+1·1
102	602·8	601	− 1·8	− ·3
103	468·0	477	+ 9	+1·9
104	363·4	375	+11·6	+3·2
105	282·1	284	+ 1·9	+ ·7

The deviations are not greater than one would expect.

The curve may easily be plotted out, if two pairs of values of L and V are known, by means of the following relation:—

If $V_1\ V_2\ V_3$ are in A P
$L_1\ L_2\ L_3$ are in G P

since the logarithms of numbers in G P are in A P.

Hence, if two points (1) and (2) on the curve are known, to determine a point (3) outside these, mark off

$$V_3 - V_2 = V_2 - V_1 \text{ and } L_3 = \frac{L_2^2}{L_1};$$

if (1) and (3) are known, to determine a point (2) between (1) and (3) mark off

$$V_2 = \frac{V_1 + V_3}{2} \text{ and } L_2 = \frac{L_1 + L_3}{2}.$$

In this way any number of points can be determined.—Yours, &c.,

F. M. WRIGHT.

12th February, 1885.

ANIMAL ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Ever since the time when a studious youth of the period decoyed a feline quadruped into the family coal cellar with the view of extracting chain lightning from its epidermis by a process of irritation which resulted somewhat prejudicially to the personal comfort of the operator, many individuals have devoted some consideration to the study of that branch of scientific research known as animal magnetism.

Other persons, whose absence of inclination or individual poverty in the matter of cats has led them to witness the *séances* of Mrs. Guppy, or the manifestations of "Ally" Slade, more or less vividly remember the cobwebbed maxim about the divorce between the unwise and their ready cash.

Despite, however, very many shattered superstitions, some people continue to throw a pinch of spilt salt over the left shoulder, or quake when a young man attired in a dress coat and a big gardenia extracts pins from the chairs on which they have been sitting. When a man whose duty, like that of the writer, has been to occupy the interregnum between attacks of coast fever by feeling the pulse of so many thousand miles of the long line which electrically connects the effete old world with the restless miasma pits of East Africa, a fraction of ex-

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citement elevates itself to the importance of an integer, and one gets into the habit of alternating funereal compositions to the memory of the dead by more or less abstruse calculations as to the chances of the living.

The idea of testing a man's vitality by insulating and testing him for electrical quantity occurred during the relaxed and peaceful condition of the mind consequent upon the subsidence of an annual flood, which left everybody on the coast line without apprehension or uncertainty as to the question of a night's lodging. Then, with the view of cheering up my associates, I proposed to take electrical tests as to their several conditions, with the idea of ascertaining whether the theory that a high or low standard of physical power was consistent with the higher or lower degree of electrical force to be found in the organisation of my subjects. With the most perfect of registers at hand—the Thomson astatic galvanometer for delicate measurements—the certainty was assured that, with a perfectly insulated subject whose accumulated stock of electricity had been discharged by placing him in contact with the "earth," no mistake could be made in the tests taken by an experienced electrician. Taking first for my subject a colleague whose veins were throbbing rapidly with the premonitory symptoms of intermittent fever, I found the deflection of the galvanometer registered 320 divisions of the scale = ·2 milamperes. Then a subject offered himself who had been indulging, in near proximity of time, in more or less violent exercise. His registration approximated to the former test, but subsequently fell when his normal temperature was restored. Next, the registration of subjects enjoying robust health was ascertained, and could scarcely be distinguished from that of the persons whose vital current had been accelerated by the excitement of exercise or febrile disturbance. Against these results I took the debilitated and the Dutch.

The Hollander, whose blood flowed with the even and dignified pace of his beloved bullock waggon, gave no higher result than that of the individual whose vitality had been reduced by illness. These experiments were repeated again and again, under every imaginable condition, and the results have tallied.

From these facts I deduce the conclusion that the more rapid the circulation of the blood the greater the volume of electricity produced. The theory is, perhaps, not a new one; but those, at all events, who have experienced no difficulty in accepting the thought-reading hypothesis may accord me at least a moiety of support.—Yours, &c.,

A. S. T. E.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Walker's involved and discursive questions are somewhat difficult to understand, and more so to answer. I can apprehend the meaning of four, more or less, which may, perhaps, be briefly dealt with as follows:—

1. I do *not* mean "that the body has the property of altering its resistance merely in obedience to the E.M.F. of the testing current without having undergone any previous physical change."

2. I *can* adduce "reason, beyond the bare fact that my measurements differ," for the statement I made, which is *not* the one given above.

3. On the several hundred "persons" observed by me, the resistance has invariably risen with "the continued application of a direct current." Mr. Walker, or "some parts" of him, may constitute an exception.

4. To the terrific hypothetical question about "some membrane, some organ, or some vessel," &c., and the effects on it of a "ridiculously small" current, I can only say I don't know.

Now for one line of fact as against pages of palaver. I have taken ten good congruous observations already on Mr. Mance's method. It works very well, and has, I believe, given me a firm basis for further research. I have submitted my first rough experiments to Mr. Mance himself, who has corrected and commented on them. The figures are singularly close to those originally obtained with momentary contacts and reversed current. Like these also, they are considerably larger than the results given with Kohlrausch's induction-bridge. I still believe, and can prove, that an imperfect conductor, like the human body, is more permeable to high tension than to low tension currents; indeed, the same is true of a wetted string. But another cause of error may still have been overlooked, in the unequal strength of induced currents at making and breaking contact. If the latter be considerably the stronger, it will not simply cancel the polarisation of the former, but leave a residuum of its own outstanding, which may easily produce a spurious lowering of apparent resistance. As soon as two cases occur which for therapeutic purposes need the "Faradic" or "continuous" currents in force, I will take the opportunity of charging both one and the other for a fixed time, and discharging through a good galvanometer.

Till then I shall not occupy your space further.—Yours, &c.,

W. H. STONE.

THE DAVEY MOTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Replying to the letter of your correspondent "Phœnix," I would explain that the ¼in. pipes are made to connect the motor with the coil, one (the supply pipe) connecting the steam space of the motor with the top of the coil, and the other (the return pipe) connecting the bottom of the coil with the air pump of the motor. The return pipe is throttled when it enters the air pump, to prevent waste of steam, as the only object of the return pipe is to take away the water formed by condensation of steam in the coil. The coil consists of 1in. vertical pipes, presenting about 20 square feet of surface.

It is obvious that the steam would not reach the coil if it were not for the return pipe and its connection with the air pump.

I find the ¼in. pipe is more than sufficient for the coil; but if I had several coils I should use a pipe of sufficient size for them.

I have had considerable experience in warming by means of steam and hot water, but I prefer steam, because with it smaller pipes may be used.—Yours, &c.,

HENRY DAVEY.

Rupert Lodge, Headingley, Leeds,
February 17, 1885.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to your correspondent "Phœnix," the Davey motor has been illustrated and described recently in *The Engineer*, *Engineering*, *Iron*, *Le Mouvement Industriel*, *The Mining Journal*, &c. With regard to the warming of the house, Mr. Davey has kindly informed me that he takes a lead pipe ¼in. in diameter from the steam space in the motor to a coil placed in the centre of his hall, and that a return pipe of the same diameter leads from the coil to the air pump of the motor, by which means he draws away the water produced by the condensation of steam in the coil.

I am safe in assuming that the ¼in. pipe working under the conditions named will convey 6lb. of steam at 212deg. per hour from the motor to the coil; and if the condensing surface of the coil were sufficient to condense that steam, 4,000 units of heat per hour, a quantity sufficient to raise over 40,000 cubic feet of air per hour 8deg. F., would have been thrown off from the coil in the house.

I have assumed 6lb. of steam only. It is evident that the quantity of steam delivered into the coil would vary with the difference of pressure in the coil, and in the motor boiler, and as that difference might well be from 4lb. to 6lb. per square inch, no doubt a much larger quantity might be delivered.

I do not wish to argue that a ¼in. pipe is necessary in every case; but I do most emphatically state that in this case it is amply large enough.

I may add that Mr. Davey informs me he has found it necessary to throttle the return pipe by reducing the diameter at one point, because the ¼in. pipe passed more steam than the

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coil could condense. The radiating surface of the coil is 20 square feet.—Yours, &c., A YOUNG ENGINEER.

DR. DAVY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was very sorry to see in your last issue an announcement of the death of Dr. Davy, whose claims as pioneer in the invention of the electric telegraph are so conclusively proved in the pages of Mr. J. J. Fahie's recent work on the "History of the Electric Telegraph." It is to be regretted that the efforts of this early investigator in the domain of science should have remained hidden so many years, and it is the more so that just at the moment when honours *were* being conferred on him, his long and useful life should come suddenly to a close.

As a Member of the Society of Telegraph Engineers and Electricians I would venture to suggest that it would be only a matter of courtesy for the Society in some way to recognise the energy displayed by Mr. Fahie in unearthing Dr. Davy's early inventions, and proving his title to be classed alongside —if not in advance of—Cooke and Wheatstone.—Yours, &c.,

February, 1885. OBSERVER.

ELECTRICITY DEVELOPED BY CONTACT OF SIMILAR METALS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I remarked in my letter of the 2nd that my experiments might not be new. Since then I have observed the following phenomena:—On moistening two silver plates with saliva and putting them in contact a deflection of galvanometer needle ensued to the right, on moistening them with distilled water a deflection took place to the left, zinc plates with water a deflection to the left, with dilute sulphuric acid a deflection to the right, with methylated spirits to the left, iron plates with water a deflection to the right, with saliva deflection to the left.

I should be obliged if any reader can give some information on the subject.—Yours, &c., W. A. RUDGE.

Holyrood-place, Plymouth.

SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.

The following is a copy of resolution to be forwarded to the President of the Board of Trade, in accordance with the decision of the council upon a first report of the committee as announced at the meeting, Feb. 12, 1885:—

"That the Society of Telegraph Engineers and Electricians have seen with regret that since the passing of the Electric Lighting Act of 1882 public lighting by electricity has not made that advance in this country which was confidently anticipated, and hence there has not been that stimulus to progress in many of the branches of electrical science which might have been expected judging from the history of submarine telegraphs.

"That the society, having had the matter under careful consideration, have come to the conclusion that the restrictions in the said Electric Lighting Act have in a great measure contributed to check the advance of public lighting by electricity, and they venture to request the President of the Board of Trade to consider whether the said restrictions may not be modified or removed."

Electrotyping with a Dynamo Machine.

The first paper was on "Electrotyping with a Dynamo," by Captain H. R. Sankey, R.E. After referring to the work and requirements of the Ordnance Survey, the author pointed out that the electrotyping as practised was subject to the following conditions:—

1. The deposited copper must be homogeneous, without grit, as hard as possible, and capable of withstanding the pressure in the press.
2. Thick deposits are required, and in the case of duplicates the deposits must be of uniform thickness.
3. The surface to be deposited upon is large, but does not greatly vary.

The experiments described were carried out with an Elmore dynamo.

It is known that the quality and texture of deposited copper depends on the rate of deposition, or, in other words, on the density of the current, and that, if the deposition be very slow, the resulting copper will be hard and brittle; but, on the other hand, if the deposition be rapid, the copper becomes granular and wanting in cohesion. It is also clear that if thick homogeneous deposits are required, the rate should not vary to any appreciable extent during the deposition. Therefore, to fulfil our requirements,

1. The density of the current must lie between certain limits.
2. The current must be kept constant during the deposition.

As regards the first condition, no published information could be obtained at the time (lately some few results by Mr. Sprague have been found). It was therefore decided to measure the current flowing in our existing baths; this was effected by means of one of Cardew's ammeters, and it was found that in different baths the current varied from 23·4 to 26·4 amperes on plates of 7·7 square feet surface. As a check, a small plate $\frac{1}{8}$ square foot was prepared, and copper deposited upon it by means of a current of 1-5 ampere, being at the same rate as 27·7 amperes on the large plates. The resulting copper was, to all appearances, the same as that deposited in the large baths. Again, rather more than 1½lb. of copper is deposited on an average in 24 hours in each bath, which corresponds to a current of 24 amperes. It was therefore decided to so regulate matters that the dynamo would send a current of 30 amperes through each bath.

To fulfil the second condition of keeping the current constant, a very steady high-speed engine, regulated by a very sensitive electrical governor, is clearly the desideratum. After an inspection of most of the principal high-speed engines now manufactured, and careful consideration, Willans' high speed six-cylinder compound expansive engine was selected as being the best suited to our experiments. Mr. Willans had also just patented an electrical governor, and the engine was accordingly provided with one of these. It is not proposed to describe this governor, as Mr. Willans is about to read a paper on the subject before the Institution of Civil Engineers. Both the engine and the governor have been found to work admirably, and have fulfilled all expectations. The governor is exceedingly sensitive, and yet does not flutter; it is, in fact, dead-beat.

The next point for consideration was whether the depositing baths should be arranged in parallel, series, or combined parallel and series.

The more usual arrangement of placing the baths in parallel did not appear to be suitable, owing to the great difficulty, if not practical impossibility, of regulating the current in each bath with that accuracy required for our work, because the baths have not quite the same resistance, and more especially because the resistance of any particular bath is not constant; so that, even if the main current were regulated, the current in any particular bath would vary. Moreover, this arrangement was adopted by Messrs. Elmore in their experiment with 10 plates, and, as already mentioned, the result was unsuccessful.

The combined arrangement is open to the same objection, though perhaps not to the same extent. As far, therefore, as the regulation of the current is concerned, it is preferable to place the baths in series; and it may be added that this arrangement was recommended by Mr. Willans when the question of winding the solenoid of the governor was discussed. It is also to be noticed that incidentally the advantages of being able to place the baths at a greater distance from the dynamo, of using smaller leads, and of having less difficulty in making connections, are gained by placing the baths in series. Accordingly it was decided to adopt this arrangement if the dynamo would admit. It was therefore necessary to ascertain—

1. How many baths would be required.
2. What electromotive force is necessary to produce a current of 30 amperes through this number of baths placed in series.
3. Whether the dynamo could be altered so as to produce this electromotive force and 30 amperes.

To calculate the number of baths required, it is considered that the total output should be 120lbs. per week, and as the dynamo will work about 44 hours per week, it follows that*

$$x \times \frac{30 \times 44}{372} = 120,$$

or

$$x = 33 \text{ baths.}$$

The resistance of the bath with plates 7·7 square feet areas and ¾in. apart was found to be 0·0087 ohm (average).

It appears that each bath requires an electromotive force of

$$30 \times 0{\cdot}0087 + 0{\cdot}016 = 0{\cdot}276 \text{ volt;}$$

so that the total electromotive force required is

$$33 \times 0{\cdot}276 = 9{\cdot}1 \text{ volts,}$$

or, say, 10 volts to allow for leads and connections.

Before mentioning the experiments carried out to ascertain whether the dynamo could be altered so as to give 10 volts and 30 amperes, it will be as well to describe the dynamo and the apparatus used for measuring the current and the electromotive force of the dynamo. The dynamo has somewhat the appearance of an alternate current machine; its armature consists of a disc of cast iron 1ft. 6in. diameter, on each side of which are fixed 10 coils wound with 7 B.W.G copper wire, and having each a resistance of 0·00297 ohm. As originally arranged, one set of the commutator segments (alternate segments) were connected to two rings, one on each side of the armature disc, but insulated from it; to these rings one end of each armature coil was connected, the other end being connected to the armature disc, which in its turn is connected to the remaining segments of the commutator. It will thus be seen that, as originally arranged, the armature coils were in parallel, so that the resistance of the armature was very low; in fact it appears by calculation to be 0·000149 ohm; and further, that the electromotive force must be very low, being that induced in one coil. The field-magnet coils are similar to the arma-

* $\frac{\text{Current}}{372}$ = weight of copper in lbs. is a convenient formula derived from electro-chemical equivalent of copper.

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TABLE A.—EXPERIMENTS WITH ELMORE DYNAMO.

Armature.—Diameter, 1′ 6½″. Arranged in two sets of 10 coils in series, the two sets being in parallel. Resistance cold, 0·0297 ohm.
Fields.—20 coils arranged in series. Resistance cold, 0·684 ohm. Placed in shunt with circuit.

No. of Experiment.	Revolutions per minute.		Steam Pressure at Engine. lbs. per square inch.	Electromotive Force.						Deduced from Current.	Mean.	Resistance in Main Leads.	Current.						
				Poggendorff's Method.									Cardew's Ammeter, R = 1,000 ohms Constant, 18,280.						
				Balancing Cells.		Resistances.			Diff. Potential Terminals of Dynamo.				Balancing Cells.			Resistance Unplugged in Box of Coils.	Current in Main Leads.	Deduced from E.M.F. & Resist.	Mean.
	Dynamo.	Engine.		E.M.F.	No.	r_1	r_2	Of leads to dyn.					E.M.F	No.	Liquid Resistance.				
32	400	130	75	1·07	2	10	*	0·67	—	6·0	—	0·33	1·07	2	10	1150	18·1	—	—
33	500	170	35	1·07	2	10	42·0	0·67	11·1	11·5	*11·3*	*0·38*	1·07	2	10	280	30·4	29·2	*29·8*
34	300	100	80	1·07	2	10	2·4	0·67	2·7	2·8	*2·75*	*0·34*	1·07	2	10	3680	8·3	7·9	*8·1*
35	415	140	95	1·07	2	10	23·5	0·67	7·2	7·5	*7·35*	*0·34*	1·07	2	10	750	22·2	21·2	*21·7*
36	540	180	100	1·07	2	10	37·0	0·67	10·0	10·4	*10·2*	*0·36*	1·07	2	10	320	29·0	27·8	*28·4*
37	600	200	100	1·07	2	10	59·0	0·67	14·6	14·8	*14·7*	*0·41*	1·07	2	10	70	36·2	35·8	*86·0*
38	710	230	95	1·07	2	10	100·0	0·67	23·2	22·0	*22·6*	*0·51*	1·07	2	10	800	43·2	45·4	*44·3*

* Not measured.

REMARKS.—The engine was worked compound for all experiments except No. 33, when it was worked simple. An additional resistance of 0·85 was placed in field magnet circuit.

ture coils, but larger, wound with the same sized wire, and each coil has a resistance of 0·0347 ohm. These coils are fixed to the cast-iron sides of the dynamo, and the armature revolves between them. The poles on each side are alternately north and south, and a north pole of one side faces a south pole of the other side. As originally arranged, the field coils were connected in combined parallel and series—that is, each two consecutive coils formed a pair connected in series, and these pairs, ten in number, were placed in parallel; the resistance of the field was therefore 2-10ths 0·0347 = 0·0969 ohm.

The armature, fields, and circuit were placed in series.

It will be observed, since the ends of the various coils can easily be got at, that by joining in series, or in combined series and parallel, the electromotive force of the dynamo can be increased up to a certain amount. It is also possible to arrange the fields in shunt with the circuit. The commutator is not merely a collector, as in most dynamos, but actually commutes the current; consequently the brushes can be arranged in different positions on the commutator so long as they bear on alternate segments. Should they, however, be displaced, so that even for an instant they bear on the same set of segments, they will begin to flare, and the current in the circuit will be considerably reduced. The same result will occur if the points of one or both brushes are not placed exactly parallel to the segments. A very small deviation from the true position of the brushes is quite sufficient to prevent any current being developed. In consequence, the adjustment of the brushes has been and is still the greatest difficulty. At first they had to be adjusted continually, and not the least dependence could be placed upon them. By altering the brush-holders and making them more substantial, better results have been obtained, but still very far from perfection.

Careful measurements were made with a Cardew current meter, a potentiometer, and a Wheatstone bridge, with results as described below.

The first experiments were made without altering the original arrangement of the dynamo, but it was found, as for that matter was expected, that the resistance of the leads and connections (namely, 0·057 ohm) was too great, and only a very small current was developed, which was, however, not measured.

The armature and field coils were then placed in series, when it was found that a current of about 100 amperes was developed through an external resistance of about 1 ohm at 600 revolutions.

The following arrangements were then successively tried:—

a. Amature, fields, and circuit in series.
  (1) Armature—two sets of ten coils in series, the two sets being in parallel. Fields in series.
  (2) Armature as in (1). Fields—two sets of ten coils in series, the two sets being in parallel.

b. Fields placed as a shunt to circuit.
  (1) Armature in series.
  (2) Armature—two sets of ten coils in series, the two sets being in parallel.

The last arrangement was found to be the most suitable for our purpose, as, in the first place, the desired electromotive force and current can be obtained at a low speed, as will be seen by reference to Table A; and, secondly, by means of an alterable resistance placed in the circuit of the field-magnets the current and the speed of the dynamo can be kept constant whilst the resistance in circuit is altered, so that the number of baths in the circuit can be altered to suit our daily requirements without altering to any great extent the speed of the dynamo. This arrangement was therefore adopted, and a coiled iron wire resistance was made which allows of 1·2 ohm being introduced into the field-magnet circuit, proceeding by 0·06 ohm. As thus arranged, the resistance of the armature is 0·0297 ohm, and that of the field-magnet coils 0·684 ohm. It is therefore evident that, so far as the dynamo is concerned, there is no reason why the baths should not be placed in series. Accordingly arrangements were made to wind the solenoid of the governor so that the whole current of about 30 amperes would pass through it, the solenoid being placed in series with the baths. This was effected by winding the coil in two halves placed in parallel, the total resistance being 0·01 ohm, or rather more than that of one bath. The governor was then fixed and adjusted by screwing up the spring until the ammeter showed a current of 30 amperes (nearly). As already mentioned, this governor has been found to answer admirably. At first the spring slackened slightly, and so reduced the current, but as soon as it had taken a set the current remained perfectly constant, with the exception of occasional rapid variations of small amplitude due to defects in the brushes. Before beginning to deposit, it was necessary to ascertain which terminal of the dynamo should be connected to the receiving-plate. This information was obtained by observing the direction of the deflection caused by the dynamo on a galvanometer placed in a shunt-circuit, and comparing with the deflection produced on the same galvanometer by an ordinary cell.

A condemned plate was now placed in one of our ordinary horizontal baths and was deposited upon for 31¾ hours, the place of the remaining baths being taken by the coiled iron wire resistance above referred to. The deposited copper was removed, and found to be of excellent quality. The weight deposited was 1,076 grammes, which corresponds to 28·7 amperes, using the latest determination of the electro-chemical equivalent of copper by Lord Rayleigh, viz., 0·003281. According to Cardew's galvanometer, the current during the deposition was 29·2 amperes.

It was observed that the back of the deposited copper was finer in grain than that deposited at the same rate by the Smee cells. It was thought that this apparent contradiction to the law that the quality of the copper depends on the rate of deposition could be accounted for on the supposition that the current from the Smee cells is variable, and this supposition is born out by the fact that numerous bubbles of hydrogen are continually rising in these cells, but not by any means at a uniform rate, so that it appeared probable that the internal resistance and even the electromotive force are continually varying. It was therefore surmised that deposits suitable for our purpose might be obtained with the dynamo, using a greater current strength than 30 amperes. To test this, the condemned plate above referred to was reduced in size so as to increase the density of the current, and the results obtained were as follow (the governor was re-adjusted and the current increased to 30·5 amperes):—

Size of plate. Sq. ft.	Current per sq. ft.	Corresponding current on plates 2′ 4″ × 3′ 4″.	Resulting copper.
5	6·1	47·0	Good.
4	7·6	58·5	Good.
2·8	10·0	77·0	Good, rather rough at the edges.

Taking, therefore, the 2′ 4″ × 3′ 4″ plates as a standard, it appears that the current can be increased to at least 50 amperes.

Since the above was written, some experiments have been made to ascertain whether there is any variation in the current from the Smee cells, but no appreciable oscillation in the current or in the electromotive force could be detected, only a gradual and very slight diminution. This matter, therefore, appears to require further research. These deposits were made in a *vertical* bath. In the first experiment (on the plate of 5 square feet) the solution was intentionally allowed to remain undisturbed. The resistance gradually increased, but the governor kept the current constant until the throttle-valve was completely open, when of course the current began to fall off.

An india rubber tube was now inserted in the bath, and air blown in by means of a small foot bellows. The large bubbles of air in rising displaced

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the solution, and very soon equalised its intensity. It is therefore hoped that it will be possible to use vertical baths, at any rate for matrices, the advantages gained being simplicity in construction and less space occupied than with horizontal baths.

Whilst the above experiments were being carried out, a matrix was laid down in one of the horizontal baths, with the intention of producing a duplicate sufficiently thick to print from. This intention was, however, not carried out, as it was found that without doubt the dynamo could produce as good copper as the batteries; and on the 10th December, 1844, Colonel Stotherd, R.E., Director-General of the Ordnance Survey, authorised the batteries being replaced by the dynamo. The experiments were thus brought to a close, and preparations are now being made for the contemplated change.

At the conclusion of Captain Sankey's paper, a number of gentlemen joined in complimenting him upon the usefulnes and novelty of many of the practical details he had described; and an opinion was expressed that similar operations may now be rendered possible on a much larger scale.

Mr. J. A. TIMMIS then read a paper on "The Working of Railway Signals and Points by Eletro-Magnets," the substance of which, however, had been delivered at the Institute of Mechanical Engineers last November, and appeared in *The Electrician* on the 8th of that month. The discussion on this paper was adjourned until 26th inst.

PHILADELPHIA EXHIBITION.

The following reports of the examinations on underground conduits have just been issued by the Franklin Institute. We have not thought it necessary to engrave all the illustrations, as many of them are merely catalogue pictures, and show nothing of the principles adopted :—

THE AMERICAN SECTIONAL UNDERGROUND COMPANY.

("A. b." of Section's Classification.)

This system consists of cast-iron conduits, built up in sections breaking joints, the joints being secured with clamps and keys and cement or other packing. All parts of each particular size are interchangeable. The conduit contains interchangeable metallic shelves and partitions, dividing it into compartments for carrying wires of different kinds. Three sizes of conduit were exhibited, each being connected to a manhole placed at every street corner, into which one or more men can enter for the purpose of hauling in the wires, making the necessary connections, &c. There are further, at convenient distances along the line of conduit, handholes for tapping the wires for house-to-house supply. As the position of these is accurately known, by opening up a few stones in the pavement a wire or wires can be tapped for house supply. This is effected by running the wires required from the nearest manhole on the upper or local shelves. Different companies can be supplied with separate compartments, and they can employ any particular insulation they prefer.

It is claimed for this system that "a metallic contact between the insulation of all wires and the earth grounds all leaking or induced currents, overcomes induction to a great extent, and renders harmless a cross in an electric light current. Further, that by the use of the copper shelves, in conjunction with telephones on metallic circuits, there is absolutely no interference whatever." The committee was unable to satisfy itself on all these points. The conduit when opened appeared to be very dry. It is stated that all condensation of moisture in the conduit takes place only under the manhole covers, which are exposed to the external air. This seems to be borne out by observations on the 9th of October, 1884, no rust being visible. This system seems to meet, in a very complete way, the question of house-to-house supply, separation of wires, facility of laying, repairs, and future expansion. It is not necessary to lay the wires in the conduit until absolutely required. It would, however, be necessary to use first-class insulated wires, as it would not be possible to keep such a conduit absolutely dry. Some provision will also have to be made for passing off gas, which tends to accumulate in the main, and might be set on fire and prove dangerous. It is estimated that the A conduit, 10in. by 15in., would cost 15,000dols. per mile, the B conduit, 6in. by 10in., 10,000dols., and the C conduit, 5in. by 8in., 5,000dols. The A size of conduit, which is laid in Chestnut-street, Philadelphia, from Third to Broad (equivalent to Fourteenth) streets—(about a mile in length)—is estimated to accommodate 3,000 wires. The B size is laid in Tenth, Eleventh, and Brown streets, and its capacity is for about 1,200 wires. By means of the large manholes and separate compartments the wires in use can be at any time taken out, replaced by others, or inspected and put back, in the shortest time and with no derangement to the pavements and streets. The size of the conduit also enables one to lay a very large number of wires. The prevention of induction would seem to be about equal to that in all systems employing iron-cased ducts, with the additional advantage of interior metallic screws and copper shelves, all well grounded, so that no current in one compartment would be likely to have any influence on those of another.

The conduits were laid down along Chestnut-street in October, 1883, and the electric light service has been continuous since the latter part of December of that year, which period included a number of severe storms, of longer or shorter duration. It has not been ascertained that any interference with the service has been suffered. The weather during the continuance of the exhibition was unusually dry, and therefore, though the interior of the conduits was dry wherever seen by the examiners, this would not establish the fact of the successful exclusion of moisture by this system under unfavourable circumstances. On this point the undersigned have been compelled to take the testimony of the officers of the company and the statements of the subscribers as to the success of the conduits for the electric light wires. Few, if any, telegraph or telephone wires were in the conduits, and as it is with these that the defects of any system would be best observed, the examiners have no sufficient data for expressing an opinion. It is the intention to introduce these insulated telegraph and telephone wires loosely, or without any casing, unless there be a long distance in which no service is ever to be made. Under these circumstances the company proposes to use a cable. Otherwise, the wires are to be laid loosely over each other in their various compartments.

A question which is intimately connected with the conduit itself is that relating to the exclusion from it of foreign matter, and especially of water. [The company has suffered from gas in its conduits, and on one occasion an explosion ensued in a manhole near the State House, but this latter caused no serious damage, and it is not thought likely that there are many localities where these conditions of gas waste under the streets are likely to be similar.]* In the streets of a city where there were great differences of level, any considerable break in the conduits which would permit the influx of a large body of water might (if the latter found free path) do considerable damage. This is an objection applicable to all hollow conduit systems. Open gratings have been employed to permit the waste gas to dissipate itself, and these gratings have often remained open during both snow and rain storms without introducing moisture into the main conduits, the water escaping by a trap at the bottom of the manhole. So far as the renters of the light are concerned there is not the least danger of the introduction into their houses of water or gas from this company's conduit, inasmuch as the electrodes are hermetically sealed in a gas pipe which leads them from the handhole. A telephone wire is laid down in the conduits, leading from the company's central office, in Eleventh-street, to Broad and Chestnut-streets corner. This was tested in the daytime, when the electric light currents were not passing. The terminal instruments were also out of order. The committee cannot, therefore, say what may be the effect of the electric light current on the telephone lines from this observation.

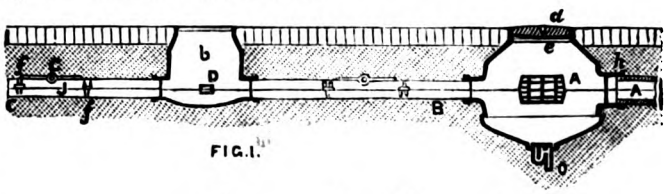

FIG. 1.

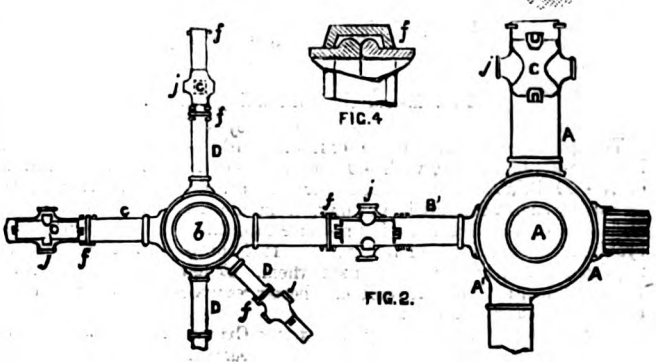

FIG. 2.

FIG. 4.

The following is a description of the figures in the cut :—

Fig. 1 represents a longitudinal elevation of various sizes of conduit A, B, C, with vertical sections through "manhole," *d*, *e*, *g*, and "flush box," *b*, showing mode of laying and connecting them.

Fig. 2, plan view of same.

Fig. 3 (not shown) is an isometrical view of section of A, conduit, and handhole, *c*, *j*, showing joints of upper and lower sections of conduit, K, K, partitions and shelves for electric wires, the "static condensing shelves" being shown by dotted lines.

Fig. 4, transverse section through top of clamp, showing section of ends of conduit and packing at joints. The letters show similar parts in the different figures, A being the largest size conduit yet made, capacity about 3,000 wires. A', showing the conduit opening in manhole when connection is made at one side of manhole or flush box. B, C, and D are consecutively smaller sizes of conduit; *a* manhole, *b* flush box, *c* handhole, *d* manhole and flush box cover made either solid or perforated for ventilation; *e*, bar with which to fasten cover by aid of bolt and nut; *f*, clamp and keys by which the different sections of the conduit are connected; *g*, trap for drainage of any water which may collect in the manholes and flush boxes from rain or condensation, and which may be connected with sewer; *h*, street bed, earth and gravel; *i*, street paving; *j*, handhole opening for house connections; *k*, longitudinal joints between upper and lower sections of conduit, to be filled with any suitable packing to exclude moisture, &c.

THE ANDERSON CONDUIT FOR UNDERGROUND WIRES.†

("C" of Section's Classification.)

This conduit is constructed of cellular section and of any suitable material, such as iron, terra cotta, or glass. It provides a series of ducts, into

* This report was completed on October 30th, 1884.

† Patent No. 261,979, dated August 1st, 1882.

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which cables or wires of different classes or belonging to different subscribers, may be accommodated. In both sides of the conduit are a series of lateral openings, formed in the process of manufacture of each length of the conduit. These openings give access to the ducts on either side, and are intended for tapping the wires at any desired point. Each side duct, on either side of the conduit, has one of these lateral openings, which are not arranged one over the other, but diagonally and in adverse directions on either side. The object of this arrangement, which appears to be the main feature of the system, is to obviate the weakening of the structure, which would result from having a row of openings one above the other. No provision is made for manholes, and no arrangements are proposed for obviating the effects of induction, nor for keeping the duct water tight or free from condensation. The description and model were not sufficiently complete to enable the committee to form any opinion of the details, but the provision of a lateral opening to each side duct would have many disadvantages.

The Brooks Underground Conduit.

("*A. a.*" *of Section's Classification.*)

This conduit consists of wrought iron pipes, supplied with suitable splice boxes, handholes, and outlets. These pipes are protected from oxidation by being laid in a wooden trough, into which hot pitch is poured so as to completely envelope the pipe. The wires to be used in this system are covered with cotton and formed into a rope or bundle, which is then covered with a textile weaving. The bundle of wires is then soaked in hot mineral oil and drawn in long lengths into the pipe or conduit. A heavy mineral oil is then forced into the pipe so as to exclude moisture, and for the purpose of maintaining a good insulation.

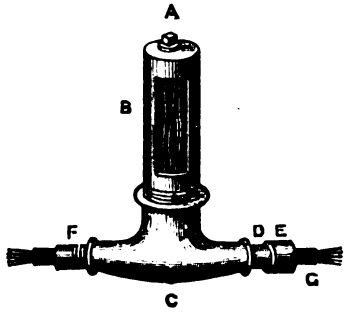

Fig. 1.—Method of Making Splices.

The patentee estimates the cost of laying a 2½in. pipe complete, for house-to-house supply, with 40 conductors of No. 16 B.W.G., and 360 of No. 20 B.W.G. at 20 dollars per mile per conductor. He states that he can lay such a conduit in one day, from block to block, so that its construction causes but little interference to traffic. The main point of the system is the economy of insulation. It is proposed to anticipate future requirements by laying down as many wires as may be required for a long time to come, and not to add or withdraw any. It is a system which seems better adapted for trunk or through lines than for house-to-house supply, owing to the difficulty that would be experienced with the overflow of oil at so many points. In towns where there was much difference of level the head of oil would doubtless be a source of great trouble.

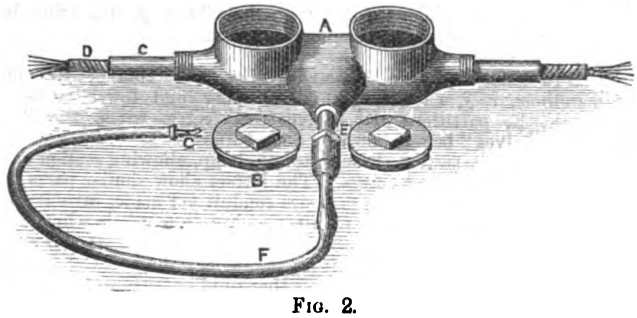

Fig. 2.

Fig. 2 shows the handholes and outlets for taking wires into adjoining buildings. F, is a piece of lead pipe, of any desired length, sufficient to reach the first story of the building in which the wires are to be extended or looped. The lead pipe F is filled with a heavy and viscid oil until it reaches within 2ft. of the point G, where it is spliced to india rubber or gutta percha covered wires. The space between the gutta percha covered wires and the lead tube is filled with plaster of Paris and silicate of soda, which effectually prevents any leakage of the oil.

Fig. 3 shows a splice-box, handhole and outlet on both sides, designed to accommodate 400 wires. C is a 2½in. diameter pipe. Reducing sockets can be introduced at B for a smaller pipe and less number of wires. These boxes are introduced at intervals, fastened with plug D, for bringing out the wires. The box is 7in. in diameter inside. When used for splicing the ends of the cable, dome F is screwed into the top of the box. G is a plug in the top of the dome for pouring in oil after the splice is made. On either side of this box is outlet E, similar to that shown in Fig. 2.

Fig. 4 shows the tank at the Pennsylvania R. R. Station, Broad-street, Philadelphia, supplying the system with pressure and the oil lost by leakage (which is not perceptible).

[Figs. 3 and 4 are not engraved as they will readily be understood from the description.]

As regards the efficacy of the oil, as a means of insulation, Mr. Brooks exhibited to the examiners this experiment:—Two wires were attached to the Holtz machine, the extremities being carried into a narrow jar of his insulating oil, in such a manner that while the distance between them was ¼in. in the oil, they were 1½in. apart at the surface of the oil. On turning the machine, the spark passed above the surface of the oil, and not at all through the oil, even when the distance between the extremities was reduced to 1-16in. A number of experiments were made as to the effect of the Brooks system in reducing induction and other disturbing elements; various circuits having been politely put at the examiners' disposition for this purpose in the Pennsylvania railroad building. One of these was a line through a Brooks conduit to the Broad-street Station, and a return through the earth. This line gave a considerable amount of disturbance, the noise being rather deep than loud, and reminding one of visible movement. The voice was carried clear and distinct. A second Brooks circuit was metallic, *i.e.*, the message went and returned by wire, the distance between the station being about 1¼ mile. The crackling noise was audible, but not loud or deep. A line to Merion Station and return, by overhead wire (14 miles), worked nearly as well. The crackling was *finer*, *i.e.*, shriller and more continuous, but not so disturbing. No means were available for testing the amount of interference with each other of the several wires of telegraphic and telephonic circuits in the same tube, worked simultaneously. 2,000ft. of wire are pulled through each length at a time.

(TO BE CONTINUED.)

THE DRAWBAUGH TELEPHONE CASE.

AMERICAN BELL TELEPHONE COMPANY AGAINST THE PEOPLE'S TELEPHONE COMPANY ET AL.

(CONTINUED FROM PAGE 280.)

The first group of facts of this nature are those which bear upon the capacity and character of Drawbaugh as an inventor, and tend to show that it is not only highly improbable but almost impossible that he could have been the author of the telephone.

In the summer of 1878 he composed a biography of himself for publication in the history of Cumberland County, which presents a graphic picture of the inventor and of the man. He commences by describing himself as "born in the quiet, secluded village of Milltown, three miles from Harrisburg," and as one of the greatest inventive geniuses of this age, who has spent the greater part of an active life conceiving and producing as the result of the conceptions of an unusually fertile brain a score of useful, ingenious machines and devices. It appears, he says, by examining a list of his inventions that the manufacturing interests of the place in his boyhood days gave direction to his thoughts and incentive to his actions. He proceeds to enumerate a list of his inventions as follows:—"His first invention was an automatic sawing machine; then a number of machines used in waggon making; then a machine for boring tenets; then a machine for sawing tenets; a barrel stave jointing machine, patented 1851. This machine was pretty generally introduced and its merits appreciated. An automatic grinding machine was next invented to meet a demand created by the introduction of the jointer; then followed several machines for making stave headings and shingles, all of which were patented in 1855; after which machines for rounding, heading, crozing, dressing and finishing outside of barrels were invented; these were again followed by device for running mill-stones, one for dressing mill-stones, a device for elevating grain in mills. He then invented and had patented four improvements in nail-plate feeding, next a tack machine and a new design in tacks. Photography next engaged his attention. He fitted himself for action in this field by manufacturing his own camera, ground and fitted achromatic lenses for camera, prepared the necessary chemicals and improved the process for enlarging pictures. Next electricity and electric machinery attracted his attention, and an electric machine was produced throwing out of consideration the galvanic battery and electric pile; then a machine for alphabetical telegraphing; then the justly celebrated electric clock and the machinery necessary for its construction; and several kinds of telephones, one of which is operated by battery and another by induction." He concludes as follows: "It will be seen from the foregoing that Mr. Drawbaugh has penetrated vast fields in search of information, and with what success we leave the reader to determine. We are proud to own Mr. D. as a citizen of our township, and deem him worthy of a position at the head of our prominent men, and are happy to accord him that position." This portrait, drawn by himself, depicts without the aid of extrinsic evidence the ignorance and vanity of the man, and the incongruous and fantastic assortment of his inventive projects. It suggests also the character of a charlatan.

That he was a skillful and ingenious mechanic is undoubtedly true. Invention was his hobby and his vocation, but that he was an inventor in the large sense is disproved by the nature and results of his work. Every patent that he obtained was for some improvement on existing devices which involved mechanical skill rather than any high degree of inventive faculty. This is shown to some extent on the face of his patents, the list of which is as follows:—

November 11, 1851, "for improvement in stave jointing machines;" May 22, 1855, "for stave machine;" April 28, 1864, "for improvement in mill stones;" May 12, 1863;" for improved machine for levelling the

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faces of mill stone;" December 12, 1865, "for improvement in nail plate feeders;" November 20, 1866, "for improvement in faucets;" November 19, 1867, "for improvement in nail plate feeding device."

His own testimony, given in an interference proceeding in the patent office in 1869, shows that none of his inventions were sufficiently meritorious to prosper vigorously. That proceeding involved a question of priority of invention between himself and one Hauck, respecting an improvement in a faucet. He had filed his application for a patent in January, 1879, and undertook to carry back the date of his invention to 1869. The scope and range of his inventive faculty became a subject of inquiry. He there testified that he had made he might say fifty inventions and had patented over a dozen. He was cross-examined respecting certain inventions to show that they did not work satisfactorily. He was then asked: "Since 1866 what machines have you conceived and perfected that have worked satisfactorily?" He answered: "To the best of my knowledge I think they all have. The nail machine gave satisfaction. I had it running in the works, but the nailers drove it out. The tram and red-staff was a good machine, and adopted by a number of millers. The magnetic clock I consider a good thing, but I am not through with experiments on it yet. I believe this last faucet to be a good thing." If his nail machine had induced the workmen to drive it out of the shop it ought to have commended itself to the capitalist. His magnetic clock had not been patented at this time, though it had been for a time the wonder and admiration of the community in which he lived; but when it was patented in 1879, it was a "new article of manufacture," consisting of a galvanic battery for electrical clocks which had two old elements united instead of being disconnected as in former devices. The history of his clock shows clearly that it was of no practical merit; and the clock had been substantially described in "Tomlinson's Encyclopædia," and he had the book before he made his alleged invention. His other electrical devices he never patented, and in his testimony in the interference proceedings he did not refer to them as among his perfected and successful inventions. One of these was his magneto-electric machine for short line telegraphing and fire alarms, sometimes mentioned as his magneto key. It was not a new device, and the proofs shew that it was a failure.

When the speaking telephone was first introduced to the attention of the scientific public it was pronounced by one of the most eminent electricians of the day "a result of transcendent scientific interest" and "the greatest by far of all the marvels of the electric telegraph." The inventions attributed to Drawbaugh include not only the conception of the principle of the unbroken, undulatory electric current, and of the delicate and complex instrumentalities essential to its efficient application in transmitting and reproducing articulate speech, but also of many other devices involving a nice adjustment of forces and requiring sensitive mechanism. These were inventions of a peculiarly scientific order which would seem to demand a special conversance with the principles of acoustics and electricity. Besides making the cardinal discovery of the theory of the unbroken undulatory current, Drawbaugh is assumed to have perfected a brilliant and extraordinary series of original discoveries for which, to use the words of Mr. Benjamin, "there is no parallel instance in the whole history of invention." Mr. Benjamin, referring to the microphone which was introduced to the public in 1878, by Mr. Blake, but which is one of the instruments asserted to have been invented by Drawbaugh at an earlier date, says, "It was looked upon as a great and original discovery."

It was said by Chief Justice Taney (O'Reilly *v.* Morse, 15 How., III.), speaking of the invention of the telegraph, "No invention can possibly be made consisting of a combination of different elements of power without a thorough knowledge of the property of each, and the mode in which they operate on each other. For no man ever made such an invention without having first obtained this information, unless it was discovered by some fortunate accident." None of Drawbaugh's alleged discoveries were made by accident. His statement is that, starting with the belief that speech could be transmitted by electricity, he made first one contrivance and then another, gradually obviating difficulties and making advances experimentally, until he finally perfected the several inventions.

In view of Bell's special equipment for investigation and experiment in electrical and acoustic science, it would not seem strange that his persistent efforts tried to effect the electrical transmission of speech were eventually successful were it not that others as intelligent, as well equipped, as ingenious and as persevering as he, had devoted years to the same object in vain. He had the assistance of Mr. Watson, an expert in electricity and a skilled workman in electrical mechanism, in constructing the apparatus employed in his experiments, and who also aided him in his experiments. He had demonstrated his inventive proficiency by inventions in telegraphy for which patents were granted to him. And yet had it not been for an accidental discovery made by him in June, 1875, and which would probably have escaped one whose trained faculties were not centred on a careful study of the phenomena, he might have failed.

Drawbaugh, on the other hand, was not only untutored, but he was isolated by his associations and occupations from contact with men of advanced science; he had narrow opportunities for instruction, and few incentives for profound research. Among the multitude of his inventive conceptions was one that a talking machine was a possibility. According to the testimony of Lory, a witness for defendants, before Drawbaugh began his practical experiments he exhibited a sketch of a machine that he was about to make that would talk a distance of twenty miles and work something like a telegraph. If this is true he commenced on his telephone as the architect plans a building or the engineer makes a draught of his structure. His own testimony shows that he did not attempt to qualify himself for electrical inventions by any systematic study after he began experimenting with his talking machine. Although he had undoubtedly acquired considerable desultory information about electricity, and especially about the mode of operation and detail of construction of electrical mechanism, it is obvious that when he commenced with his talking machine he was a tyro in electrical science, essaying the most difficult work of the electrician.

(TO BE CONTINUED.)

LEGAL.

UNITED TELEGRAPH COMPANY V. SHARPLES.

This was an action brought by the United Telephone Company, in the Chancery Division, against Mr. George Sharples, an electrical agent, dealer, and manufacturer, of Preston, for an infringement of the electrical patents of Bell and Edison. Mr. Aston, Q.C., with whom was Mr. Moulton, explained that the defendant had obtained for exportation telephone apparatus from a firm called the "American Telephone Company," Rotterdam; but he had tested such apparatus here, and retained sample machines, which he submitted was a user in this country, and consequently an infringement of the plaintiffs' patent. Defendant had further infringed the patent by offering for sale all the component parts of Bell's and Edison's telephone, which constituted, when put together, the complete apparatus, and had also committed an infringement by having had made for him Hinckley's and Crossley's receivers. Taking all these circumstances together, he asked his lordship to grant an injunction.—Witnesses, called in support of plaintiffs' case, showed that the company sold the machine under special conditions to railway companies, but lent them out to customers on payment of royalty.—On behalf of the defendant, Mr. Hastings, Q.C., with whom was Mr. Goodeve, submitted that, as to the machines imported from Holland, the defendant had acted in a perfectly lawful manner, because the machines had been imported for experiment, so that there was no user for profit, which was a necessary element in an infringement. No user had been proved; and, as a matter of fact, the infringing instruments had not been used at all.—Mr. Sharples, the defendant's son, stated that he first heard of the machines complained of from a Mr. Bateson, who represented that they might be useful for experimental purposes, and he wrote the letter ordering some of them, as the cost was small, but none of the machines had been sent to customers abroad; and as soon as this action was commenced the machines were given away and exported. Evidence was also given to the effect that the instruments sent to the defendant at Preston by the Rotterdam Company were for experiment and for teaching his pupils their business; that the machines were not exported abroad until after the commencement of the action, when they were presented to Messrs. Berline, of Manchester, who have a house at Moscow, the instruments being sent to the latter place by the advice of defendant's solicitor. Defendant's counsel having summed up the evidence, Mr. Justice Kay, without calling on plaintiffs' counsel, gave judgment. He said the balance of evidence was in favour of the plaintiffs' theory, and he therefore held there was clearly an infringement; while the mode in which it was done, and the mode in which it was now sought to defend what was done, called for his strongest reprobation. He ordered that there be a perpetual injunction against the defendant Sharples, restraining him, his workmen, and agents from infringing the patents included in the plea of the plaintiff company, ordering him to pay all the costs. With reference to this case, the company's solicitors have written to the *Standard* to the effect that, contrary to that paper's statement, that the judge held there had been no user, and had dismissed the action, with costs, his lordship, after commenting somewhat forcibly on the evidence given in the witness box by the defendant's witnesses, granted a perpetual injunction, with costs against the Defendant.

COMPANIES' MEETINGS & REPORTS.

The Submarine Telegraph Company.

The half-yearly ordinary general meeting of the proprietors in this Company was held at the Company's offices, 2, Throgmorton-avenue, on Tuesday last, Sir Julian Goldsmid, Bart., presiding.

The SECRETARY (Mr. S. M. Clare) having read the notice calling the meeting, the Company's seal was affixed to the register of shareholders. The Directors' report and statement of accounts were taken as read.

The CHAIRMAN then said: Gentlemen, in moving the adoption of this report, there are a few matters in it with regard to which I have to make some observations on behalf of the Board. You will observe that the receipts are somewhat less than they were in the corresponding period of 1883. Well, that is accounted for in various ways; but principally by the fact to which I have referred on several previous occasions, and which is also alluded to in the report, that a condensation of messages has been going on for some years past, and appears still to continue. There are some curious observations to be made with regard to this circumstance. For the half year up to December, 1883, the number of messages was 1,396,634; up to the June half of 1884 it was 1,377,419—a smaller number of messages, you will observe: and up to the December half of the same year it was 1,428,520, a larger number of messages than for either of the two previous half years. But, nevertheless, the largest number of words was in the half year ending December, 1883, namely, 17,226,788 words; while in June, 1884, the number was 16,583,147, and in December of the same year 17,007,776; so that actually we got in December, 1883, nearly 32,000 messages less, whereas we had then over 200,000 more words transmitted. That shows you, therefore, the reason why our receipts are less. Or, to put it in another form, the average number of words per message in 1883 was 12·33; in June, 1884, it was 12·04; and in December, 1884, it was 11·91.

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Therefore, you have to compare 11·91 with 12·33, showing the average length of messages, to arrive at the main explanation of the difference in receipts. Mr. Clare has been good enough to show me many facts with regard to this difference in our returns, and there is one very curious circumstance that I have not mentioned before, which it may interest the proprietors to know, to whom we are always glad to give information on these matters. It appears, as you will see by the figures that I am about to give, that the average length of messages in the winter months is less than it is in the summer months. In January of last year the average length was 11·92; in February, 11·99; in March, 12·14; in April, 12·07; in May, 12·08; in June, 12·02; in July, 12·07; in August, 12·16; in September, 12·02; in October, 11·70; in November, 11·62; and in December, 11·89. Consequently, when I look at these figures, I find that the highest average is in August, and the lowest is in November, and that the summer months are better than the winter. What the reason is I cannot say. It may be that there is more public business going on when Parliament is sitting, or there may be other reasons to account for it. There is the fact, however, and I desire to put that before the proprietors. That practically shows the small items of differences, and that is the main point to which I have to refer. On the other side, you will observe that there is a considerable increase in expenditure, and of course the shareholders, like the Board, are anxious to know the reason of this increase. There are several items which will explain it almost immediately. One is that the salaries of the French clerks—that is to say of the clerks that are employed on the stations in France, which are by our concession fixed by the French Government—have been increased by the French Government, and therefore all that we have to do is to pay, and that being so, we have had to pay £270 9s. 6d. more on that account. There is another point with regard to the French Government to which I will refer immediately. Then, according to the arrangements under which our clerks have come into our service, and many of our general *employés*, there is a gradual scale of rise which was settled some years ago. The system has been adopted generally by telegraph companies, and is the only one that is found to work satisfactorily, and the result has been that a considerable number of clerks have risen into the higher scale. This has increased our payment by £992—which includes the £270 additional paid by the French Government—so that we have increased under that head a little over £700. In addition to that there has been a small increase in the repairs to premises, a small one in rates and taxes which we cannot alter, and an increase of £465 in the repairs to cables. That increase of £465 was owing to the necessity of putting a very considerable length into the Dieppe cable. I believe that the cables are in capital order, and it is of very great advantage to us that the new cable between Holland and England has been laid down by the Post Office. I look forward, instead of an increase of expenditure from this item, to a diminution. A small item of increase has been involved in the repairs to the steamer, which is, I may say, in better condition than it has ever been since we owned it. After a great many years' work, our surveyor and Lloyd's surveyor reported that the cylinders of the vessel were not fit to be used any longer. Everything wears out on steamers as well as on shore, and the result was that we had to put new cylinders into it. That cost us £1,655, but it came out of the fund which has been provided for repairs to the steamer from time to time, and therefore it does not affect this half year's dividend. But there were certain general repairs which we thought it desirable to effect in order to put the ship in a perfect condition, and we accordingly did them. On the whole, I must say, as far as I am concerned, that I do not think that this condition of affairs is unsatisfactory. But there is one thing that I have to mention which is not satisfactory, and that is this—in the course of last year the French Government made an application to us of an entirely new character. Our relations with the French Government during the many years of the concession have been regulated of course by that concession, and up to last year no such demand as the one which I am now about to mention was ever made upon us. But last year they applied to us not only for the payment of clerks at Calais, Boulogne, Dieppe and Havre, our four coast stations where our cables are landed, and where they are connected with the French Government lines, but they also asked us to be good enough to pay what we never paid before, namely the clerks at Paris, Bordeaux, Lille, and Rennes, who were employed on the wires directly connected with London. For instance, there is what is called a special Bourse wire from the Stock Exchange here to the Bourse in Paris, and they proposed that we should pay the clerks engaged on it. Well, according to the wording of the concession, which has been acted upon as I say during all these years, we have no doubt that this demand was not a legitimate one. But we took the very best advice of lawyers accustomed to international contracts both in England and in France, and our view has been strongly confirmed. At the same time, in a memorandum which we placed before the French Government, we told them what our position was in this matter; but M. Cochery did not express himself satisfied, and nearly six months ago cited us before the Tribunal of the Seine, which in the first instance would have to investigate this matter. In answer to the citation, the most able lawyer in France had drawn up a very admirable statement on behalf of the Company, and it was presented three months ago, but from that day to this no further step has been taken by the French Government. When we look at all the facts of the question, I think we shall be able to prove to the tribunal that this claim is perfectly unfounded. But I do not desire to say anything more about this, and I trust when the case comes before the tribunal that it will be decided in our favour. The additional amount which will be drawn from the revenue of this Company, if the French Government should turn out to be successful, will be the sum of £3,618 13s. 9d. That of course is a very serious amount to be charged with; and, consequently, I think it is the business of the Board to resist it if possible. I do not think it is desirable that I should say anything more on the subject. It is a delicate matter, and has to be treated by the Board with the greatest possible care. We are very anxious to act in a friendly way with the French, Belgian, and Dutch Governments. So much with regard to the general business of the Company. The new cable, as I announced, which the Post Office laid down to Holland is an admirable one, and was completed with the assistance of our engineer; and the Post Office are now repairing the second Dutch cable by putting in a large amount of new wire. After that, I believe that both these cables will be in excellent order; and I may say that we have done our best to maintain our property in as good a condition as could be. I think, on the whole, though the dividend is slightly reduced, owing to the decrease of income and the increase of expenditure, even now under the unfavourable circumstances of trade and the complications in the East a dividend at the rate of 14 per cent. per annum is not to be despised, and therefore I, for my part, have much satisfaction in proposing to you that the report now submitted be received and adopted.

The Right Hon. ROBERT BOURKE, M.P., seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by the Hon. ASHLEY PONSONBY, a dividend at the rate of 14 per cent. per annum, free of income-tax, was subsequently declared.

Mr. ROSTRON proposed, and Mr. SERMON seconded, a vote of thanks to the Chairman.

The CHAIRMAN: Gentlemen, I am much obliged for the observations that have been made by Mr. Rostron and the seconder of the resolution. The Board are anxious to do their best in the interests of this Company, and I for my part am desirous to give the shareholders all reasonable information so long as I have not to say anything that would prejudice us in our business. There are in this business, as well as in others, some little secrets that we do not like to divulge to all the world.

The proceedings then terminated.

The Maxim-Weston Electric Company.

An ordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Wednesday last, under the presidency of Mr. Hugh Watt, the managing director.

The notice convening the meeting having been read, the Directors' report and the statement of accounts were taken as read.

The CHAIRMAN said: Gentlemen, it is now about nine months since I had the pleasure of addressing you, and, from the report and balance-sheet placed in your hands, you will have seen the result of the Board's work during that period. I have no intention of reminding you that in no decade during this century has the commercial temperature approached so near to the zero of starvation, or of the fact that few, if any, of the stable industries of our country have shown any return upon capital, as these facts are familiar to every shareholder in the Company. But for the state of trade the returns we would have been enabled to show would have been more in accordance with my hopes and expectations of a year ago, and more commensurate with the efforts of your Directors. Another event which has materially interfered with this Company has been the state of chaos in which the affairs of the Lancashire Company was found. As a proof that the policy I proposed to the Lancashire Company, viz., to confine their business to sales, was a correct one, since June of last year ten installations have been sold in Lancashire, and there are now in Manchester and Liverpool some of the largest private installations of our systems which are to be found in this country. In the matter of prices, as the American Company decided to abandon Maxim dynamos and lamps, I was enabled to lay in a large stock at very low prices, all of which I have since sold, so that the profits we have made are, to a large extent, due to large reductions in the purchase prices, as well as to the fact that recent improvements in appliances have enabled us to run a much larger number of lamps off the same machines, enabling us to maintain the sale prices in most cases at those of last year, and yet show a large relative reduction to purchasers. I think you will, from what I have said, fully appreciate the vantage ground the Company now occupy compared with a year or two ago. There is now only one branch in which the Company cannot be said to be in the van of progress; and as we have inquiries for the execution of large orders in this department, we are now actively engaged in formulating the data to enable us to alter the proportions of our dynamos, so as to compete and, I hope, secure large orders during the present year. We have recently had to increase our staff materially, so as to finish with promptitude the orders in hand. At present the Company have sufficient work to keep us engaged for three months. The expenses of the Company are now on the lowest possible scale. In every department economy has been the order of the day, and I have personally superintended nearly every detail connected with the practical at the works, and the commercial and financial at the offices. I will now refer to the report and balance-sheet; but before doing so, allow me to thank numerous shareholders for their kind letters, and to assure those who have sent queries that I am at all times pleased to find my co-proprietors showing an interest in the business of the Company. And first to deal with the most important part of it—namely, the profit and loss account. You will observe that considerable economy has been effected in working expenses, which have, however, slightly exceeded my estimate, occasioned by the necessity for an increase to our staff. Since the 1st January, 1885, we had to nearly double our staff, so as to complete within the desired time contracts now in hand, some of which are larger than any we have yet undertaken. As you will see by the balance-sheet which has been placed in your hands, the net profits for the nine months from 1st April, 1884, to 1st January, 1885, are £4,975 13s. 2½d., which is nearly equal to a dividend at the rate of 6¼ per cent. per annum. From this sum, however, has to be deducted the deficit to the debit of profit and loss account last year, after crediting the reduction of capital then agreed to, and since

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sanctioned by the Court, which with further sums we have had to pay in connection with contracts entered into by the old Board amounts to the large sum of £2,544 14s. 7d. The reduction thus caused makes a very great difference in the net balance for the nine months. And now, with regard to the balance-sheet, the first item, patents, remains as formerly, although the Company now possess a new self-regulating dynamo of great efficiency, equal, I believe, to anything in the market, and much cheaper than our new Weston, and I reaffirm what I stated last year, viz., that the new patents acquired by this Company during the last twenty or twenty-one months are themselves intrinsically worth the whole amount charged against patents account, independent of all the other patents in the possession of the Company, besides those of which we may become possessed, we being entitled to all new inventions of the American Company up till 1887. Looking at the question from another point of view, I think you will agree with me that the Company is now in a position to justify us in assuming that in the near future your Directors ought to be able to declare dividends on a scale which investors in such an enterprise are entitled to expect. The next item, as you will see, remains very much the same as last year, although all the stock excepting fixed plant now in hand is new. The third item, viz., securities, is the same, excepting the shares in the Scotch Company, which I succeeded in selling at a price slightly in excess of my last year's valuation. The fourth item, debtors to the Company, is a large one—more so than last year, if you include cash due from the Lancashire Company, which was dealt with last year among the ordinary trade debts due to the Company—owing to the fact that a large portion of this consists of shipping orders and consignments not very long ago despatched, we having found it advantageous to replace stocks sold at once, thus saving a delay of several months in time. This branch of the business the Directors have been pushing energetically, as we find it easier to get our list prices abroad than at home. You will, I am sure, agree with the Directors that the reserve of £800 was a wise step to take, even although it militated against the amount of dividend paid, and although the debtors to the Company are of an exceptionally good class, the Board having exercised the greatest care so as to prevent bad debts, preferring rather to let orders go past us. Fifth, that of creditors, you will see the claims are small, and at the present moment these, excepting two small American drafts not yet due, have been paid. The balance-sheet is prepared, therefore, exactly on the lines of last year. The present Board have throughout conducted its business on the cash principle as regards payments, which you can understand has been a somewhat difficult matter in view of the business we have done—one quarter's business alone amounting to nearly double the capital of the Company—and the fact that when the present Board took office we had second-hand plant worth not more than £3,000 of market value ; and the surplus left from the shares, chiefly subscribed for by my friends and self, after paying the old Board's debts, amounted to only about £2,500. Thus, gentlemen, the result of our first year's trading has led to a net profit of nearly 50 per cent. of our capital, and the last nine months of nearly 100 per cent. net profit. To rescue a company from the verge of the irrevocable precipice of liquidation, sunk in debts, with expenses of about £17,000 a year, against a revenue of about £3,000, with commitments of a ruinous character, the liquidation of which has even during the last nine months cost us an expenditure of about £500, has not been child's play. I will not detain you longer, and I have only to add with regard to dividend that this is necessarily small, as the Board had to make up the deficit in profit and loss account last year before making any return to the shareholders. I think I have now touched on all points requiring reference in the report, balance-sheet, and profit and loss accounts, and do not know that there is any other point of interest to which I can refer. Gentlemen, I am glad to see from the large and influential attendance here to-day, at an hour which is probably not convenient to some of you, that so many shareholders feel an interest in the Company. Without detaining you longer, I beg to move the adoption of the report and accounts and payment of the dividend of 5 per cent. for four months, payable as soon as dividend warrants can be printed and sent out. I should explain that I am entirely responsible for the recommendation that has been made with regard to the dividend. My colleagues certainly did not emphatically differ from me on the subject, but, as I have stated in the short address which I have ventured to submit to you, you are as well aware as I am that the cash reserve of the Company is a very small one, and I may say, therefore, that my colleagues have some diffidence as to my proposal, and have since expressed to me their personal feelings to the effect that a wiser course to pursue under the circumstances would have been to carry forward the entire balance. Of course you know, gentlemen, that is a matter for your arbitrament. I must say, however, considering the fact that for two or three years we have paid no dividend, and bearing in mind that many people are mixed up in this Company who can ill afford to lose the money they have invested in it—invested, too, at the fictitious prices paid some years ago—I felt it my duty to submit the proposal I have done, seeing that we can honestly show a surplus. At the same time, as my colleagues have considerable aversion to that course, for which, as I say, I take the responsibility, if any gentleman here has any proposal to make with regard to it, I am sure we shall all be pleased to listen to it before going any further in the matter.

Mr. Louis Swaby seconded the motion.

Mr. Gray said that, with regard to the payment of a dividend, he must say that, like every shareholder in every other company, he would like to "taste blood." He was most agreeably surprised on reading the report to find in it the suggestion made to declare a dividend in an electric lighting company—a condition of things which hitherto they had not had the good fortune to experience. But he would ask the Chairman to reconsider whether it would not be better, in the interests of the shareholders, not to pay the dividend, and reserve the money for the working purposes of the Company. The whole social and commercial atmosphere was full of electricity at the present moment, and he saw a great future for electrical industry, and having regard to that fact, he made the suggestion to withdraw the recommendation. He concluded by moving an amendment to the effect that the motion as proposed should be accepted, subject to the proviso that no dividend be declared at present.

Mr. Makewood seconded the amendment, believing that it would be the wiser course for the Company to adopt, seeing that as yet they were not financially in a very strong position. He had no doubt that by so doing they would more than recoup the apparent sacrifice they were making by giving the Company a better status, and enabling it to carry on its work more cheaply and effectively.

Mr. Gray was here understood to ask what the relations of the Maxim Weston and the other companies were with respect to the competition for business.

The Chairman said that since he became connected with the Maxim-Weston Company he had made it his duty to attend to his own business. He never paid the slightest attention to that of any other companies When they had crossed his path in honest competition he had done his best to oust them. Where he had failed he had submitted, as any man ought to do. He had often met with very dishonest competition. He thought that when a man gave £100 value for £20 it was very dishonest competition, and the Board had had to contend with something like that —with companies, for example, if not in liquidation, in the chrysalis stage of it, to whom the realisation of their plant meant a matter perhaps of directors' fees—he did not know that for certain—but at any rate some assistance to carry on the undertaking for a little longer. During the past year they had had to fight a hard battle to keep the concern going, and they had now pretty well established a good business. With regard to the Lancashire claim of £10,000, Mr. Dever, the auditor, thought, and he (the Chairman) agreed with him, that it ought to appear as a separate item in the accounts, and should not be included, as Mr. Gray had hinted under the first item on the credit side of the balance-sheet, namely patents, which stood at £70,000. With regard to the closing of the books for nine months, he might explain another point. In revising the Articles of Association in connection with another matter, they came on a clause making the year end on a certain day, and discovered that they were labouring under a misapprehension as to the interpretation of these Articles. As least such was the opinion of their solicitors, which, of course, he did not wish to set against the opinions of those who had gone before ; but at the same time they believed that the books ought to be closed on the 31st of December of each year, and when they came on the clause referred to he rapidly took stock at the works, in conjunction with the works manager, and hastened the preparation of the balance-sheet as soon as possible. The amount of cash at the bankers, and bills—a thousand guineas—might appear small, but it must be remembered that they sent out their accounts quarterly, and naturally they did not send out their Christmas accounts until the second week in January. But as far as they could ascertain all their debts were good. He might mention the circumstance, as a proof of the value of their assets, that within two weeks from sending out these quarterly accounts they received a sum equal to a third of the entire amount outstanding. Considering that a large sum of that was due abroad, and could not be received otherwise than by remittance, they would understand that that was a large percentage to be received so soon. He was extremely sorry if he had made a recommendation to declare a dividend of which they did not approve ; at the same time he trusted they would give him credit for failing on virtue's side. He was anxious to make some return to the shareholders. He thought it right to say in regard to the amendment that had been proposed, that he had received proxies against the payment of the proposed dividend to the extent of 30,000 shares ; and he took it as an exhibition of confidence in the present Board that the honourable proprietor who proposed the amendment, and who was about the largest shareholder in the Company, had been pleased to say he would prefer not accepting the dividend recommended One of the most eminent authorities on electric lighting in this country said to him (the Chairman), in pressing him to give an exhibition of their appliances—a thing hitherto contrary to the policy of the Board—"I consider that no exhibition in this country would be complete without an exhibit of the Maxim-Weston apparatus." There was no doubt that Weston had made for himself a good name in America. They might not be so conversant with the matter as he (the speaker) was, but he agreed to give that exhibit, and possibly in a few months' time they would see one of the most perfect displays of their system which had yet been shown in this country.

Mr. Parnell thought, after what the Chairman had said, it would be foolish to decline accepting the dividend, seeing that the business was increasing and prospering.

Mr. John Brown (Director), who was asked by a shareholder to give the reason why he was averse to the paying of a dividend, said that he thought if the money to be divided were left in the coffers of the Company it would be returned to the shareholders not only doubled, but trebled before the year was out. The Company could do more with the money as working capital than the shareholders could with it as a small dividend.

The Chairman, in reply to another question, said the Company could unquestionably afford to pay the dividend, otherwise he would not have recommended it. He did not regret making the proposal, having acted according to the best of his judgment, and if he had erred he was sorry for it, now that it appeared the feeling of the shareholders was against the recommendation. He ought also to mention that Mr. Dever, an auditor of great experience, was in sympathy with the view of Mr. Gray. He then put the amendment in the usual manner and declared it carried.

A letter from Mr. Dever, bearing on the subject of the balance sheet was here read.

Messrs. Brown and Watt, the retiring Directors, were afterwards re-elected, and Mr. Henry Dever re-appointed auditor.

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Mr. GRAY, in a few sentences eulogising the services of the Board, proposed that Mr. Brown and Mr. Swaby should receive £100 each as an honorarium for their labours, and that it should be made an annual charge to the Company.

The CHAIRMAN having offered a few remarks bearing testimony to the zeal of his two colleagues, and the amount of hard work they had gone through in the interests of the Company,

A SHAREHOLDER seconded the motion, and it was carried unanimously, and a vote of thanks having been passed to Mr. Watt the proceedings terminated.

Lancashire Maxim-Weston Electric Company.

An extraordinary general meeting of the shareholders of this Company was held at the City Terminus Hotel, Cannon-street, on Thursday last, for the purpose of considering, and if approved passing the following resolutions:—1. "That the sanction of the Company be hereby given to the terms of compromise by the liquidators of the Company of the two actions now pending in the High Court of Justice, between the Company and James Thornton Dadson, and between the said J. T. Dadson and the said Company and Hugh Watt, contained in an agreement dated the 21st day of January, 1885, and made between the liquidators of the said Company and the said James T. Dadson and the said Hugh Watt, whereby it is in effect provided that the actions shall on the payment by the said James Thornton Dadson to the liquidators of the sum of £737 10s. be compromised." 2. "That the sanction of the Company be hereby given to the terms of compromise by the liquidators of the Company, of the action now pending in the High Court of Justice between the Company and Gustavus Palmer Harding, contained in an agreement dated the 2nd day of December, 1884, and made between the liquidators of the one part and the said G. P. Harding of the other part, whereby it is in effect provided that the said action shall on the payment by the said G. P. Harding to the liquidators of the sum of £850 be compromised."

On the motion of Mr. GRAY, seconded by Mr. THOS. CORDELL, Mr. Hugh Watt was called upon to preside.

The CHAIRMAN having read the notice calling the meeting, said that with regard to the business before them, which was embodied in the two foregoing resolutions, he trusted every shareholder would agree with him as to the desirability of compromising these actions. At the same time he must say this, more especially as there was at least one gentleman present who was as familiar as he (the Chairman) was with the whole history of this Company, and he thought it due to the Company, in the formation of which he took an active part along with that gentleman, to point out that the Lancashire Maxim-Weston Company started under most favourable auspices. There had been a neucleus of the business formed there, and in the event of the capital which had been applied for and allotted having been paid, the Lancashire Maxim-Weston Company would have occupied a position to-day second to none in this country. He did not think that could be questioned. Nor could it be questioned, he believed, that the action taken by certain gentlemen in connection with the Company who had duly applied for and had had allotted to them a large number of shares had largely helped to bring about its collapse. The non-payment by those gentlemen of their calls placed the Company in a most unfortunate position. No one could regret that more than he could, because he was responsible for a considerable amount of the capital subscribed. He thought it only justice to the promoters of that Company, who were the parent Company, no promotion money having been paid, no cash payment having been paid to them, and remembering that even the plant which was there and fairly valued was only paid for to this day to the extent of about two-thirds its value, he thought it only justice to them and to the honourable Board of that Company to say that he sincerely regretted the condition in which the undertaking stood to-day. It was through no fault of theirs, but through the non-fulfilment of contracts entered into by certain parties, with regard to which all he could say was this—that so far as the Company was concerned every condition was complied with which was asked for or agreed to, and their nonfulfilment was simply because to his mind the market went against them, and the shares were not of the par value which had to be paid for them. There was no future for this Company, so that he trusted the compromise which had been effected—he might say after very great trouble, because one of the parties was not resident in this country, and had, as far as he (the speaker) knew, no effects in this country which could be seized, and by means of which the payment could be secured—would be approved by the meeting. He thought that the compromise arrived at in respect of the second party was the best that under the circumstances was possible. In justice to the liquidators he must say, before sitting down, that having done what in them lay to further the objects of this liquidation, having gone to a vast amount of trouble, and been untiring in their exertions to bring about the best settlement of the affairs of this unfortunate enterprise, they were entitled to the best thanks of those interested in the concern, and out of deference to those gentlemen he hoped, in moving the resolution, there would be shown that unanimity in the meeting which he thought was only a fit recognition of the labours the liquidators had undergone. He concluded by formally moving the first resolution, which was seconded by Mr. SWABY, and carried unanimously.

The CHAIRMAN then proposed the second resolution, which was seconded by Mr. WHITWORTH, and agreed to.

Mr. BROWN afterwards gave a brief history of the circumstances which led up to the compromises referred to in the resolutions.

This concluding the business, the CHAIRMAN reminded the shareholders that there would have to be a confirmatory meeting, and suggested that the question of granting some special increment to the fees of the liquidators should be considered at it.

A vote of thanks to the Chairman brought the proceedings to a close.

India Rubber, Gutta Percha, and Telegraph Works Company.

Directors' report for the year ended 31st December, 1884, to be presented at the twenty-first ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel on the 24th inst., at 12 o'clock noon.

The net profit for the past year amounted to £68,968 10s. Adding £37,902 3s. 3d. brought forward, and deducting £15,600 interim dividend paid in July, there remains a disposable balance of £91,270 13s. 3d. The Directors have added £20,000 to the reserve fund, and recommend the distribution of a dividend of one pound per share, amounting to £31,200, and making, with the interim dividend, a total payment for the year of 15 per cent., free of income tax, carrying forward £40,070 13s. 3d. Both in general sales and in cable work the amount of business has been considerably in excess of that for 1883, apart from the cables manufactured for the Spanish National Submarine Telegraph Company, the laying of which is completed, the subventions from the Spanish and French Governments being regularly paid. The Company's Bill in Parliament was passed last year. The Directors, in view of the steadily increasing business of the Company, have long felt that great advantages would be secured by having available a considerably larger amount of working capital. In this connection the reserve fund has been of the greatest value to the operations of the Company; but now a still wider development of business is opened up, not only by the continued growth of old branches, but also by the new work authorised by the Company's Act of Parliament. They have therefore resolved to increase the capital, in accordance with the powers conferred upon them by the special resolutions of the shareholders in June and July, 1864, by the issue of 10,400 shares of £10 each, thus increasing the total issued capital from £312,000 to £416,000. The new shares will be allotted to the shareholders at the price of £15 (being at a premium of £5 per share), in the proportion of one-third of a new share for every old share, or one new share for every three old shares.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. FEB. 18.		BUSINESS DONE WEEK ENDING FEB. 18. Highest.		Lowest.	
Anglo-American	30,	31		30¾		30¾
Do. Preferred	54,	55		54		53¾
Do. Deferred	7½,	7¾		7⅞		7½
Brazilian Submarine	11,	11¼		11¼		11
Cuba	10¾,	11¼		11		—
Do. Preference	17½,	18½		17½		—
Direct Spanish	1⅞,	2¼		2 3-16		—
Do. Preference	10½,	11½		11⅛		11
Direct United States Cable	9⅛,	9¾		9¾		9½
Eastern Telegraph	11⅞,	12½		12½		11¾
Do. 6 per Cent. Preference	13¾,	14¼		14 1-16		13 15-16
Do. 5 per Cent. Debentures, 1899	105,	108		107½		—
Eastern Extension	12⅜,	13		12 15-16		12 11-16
German Union	9½,	10		—		—
Globe Telegraph and Trust	6¾,	7¼		7 1-16		6¾
Do. Preference	12⅜,	12¾		12 13-16		12 11-16
Great Northern	15,	15½		15 1-16		—
Indo-European	82,	83		—		—
Reuter's	7½,	8		—		—
Submarine	190,	195		190		187
West India and Panama	⅝,	¾		¾		—
Do. 1st Preference	7½,	7⅝		7⅝		7 9-16
Western Brazilian	6⅜,	6⅝		6½		—
Western Union 7 per Cent. 1st Mortgage	120,	125		—		—
Do. 6 per Cent. Sterling Bonds	100,	103		—		—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16		½		—
Oriental	⅛,	⅜		—		—
United Telephone	11,	11¼		11 7-16		11⅛

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞		1¼		—
Do. (fully paid)	3,	3½		—		—
Hammond Light (£3 15s. paid)	¼,	⅜		⅜		¼
Swan	¼,	⅜		—		—
Maxim-Weston	¼,	½		½		¼

MISCELLANEOUS.

Telegraph Construction	34½,	35½		35⅜		35⅛
India Rubber, Gutta Percha, and Telegraph Works	21,	22		22¼		22

TRAFFIC RECEIPTS FOR JANUARY, 1885.

COMPANIES.	Jan., 1885.	Jan., 1884.	Increase.	Decrease.
Cuba Submarine	3,000	3,009	—	9
Direct Spanish Telegraph	1,770	2,072	—	302
Direct United States	—	—	—	—
Eastern Extension	44,144	41,129	3,015	—
Eastern Telegraph	87,249	85,503	1,746	—
Great Northern	20,800	19,360	1,440	—
Submarine	—	—	—	—

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NOTES.

TELEGRAMS FOR AMERICA.—The cable of the Direct United States Cable Company has been repaired.

REMOVAL.—The offices of the New Telephone Company have been removed from 39, Lombard-street, to 4, Great Winchester-street.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 20th February amounted to £3,491.

LALANDE AND CHAPERON'S BATTERY.—Forty couples on this system have been installed in the Paris central telegraph office, in place of 200 Callaud couples.

APPOINTMENT.—Mr. Henniker Heaton has been appointed by the Tasmanian Government to represent them at the Telegraphic Convention at Berlin in May next.

LIGHTING ON THE GOTHARD RAILWAY.—The first locomotive fitted with electric light apparatus lately left Lucerne for the St. Gothard Tunnel, and it is said that the company intends to apply the system to all its trains.

THE TELEPHONE IN THE NORTH OF ENGLAND.—It is said that the Northern District Telephone Company are about to connect the Hartlepools with Sunderland and Newcastle, and with Stockton, Middlesbrough, and Darlington.

FRANCO CHINESE WAR.—The *Daily Telegraph's* Paris correspondent wires that General Brière de l'Isle is at present engaged in repairing the Bac Le road, and in establishing telegraphic communication between various places.

ELECTRICAL LIGHTING AT THE SOUTH KENSINGTON MUSEUM.—It has been decided to use a set of the Electrical Power Storage Company's accumulators for the maintenance of 100 lamps in the Science and Art Department.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 20th February were £2,760, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

SOCIETE BELGE D'ELECTRICIENS.—One of the youngest of scientific bodies, the Société Belge d'Electriciens, has already made great and commendable progress. During a year of existence no less than 240 candidates for membership have been elected.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th Feb. were £2,319, as compared with £3,031 in the corresponding period of 1884. The November receipts, estimated at £4,456, realised £4,514.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY. Notice is given that the transfer books of the company will be closed from the 23rd inst. to the 3rd prox., both days inclusive, preparatory to the payment of dividend to all shareholders on the register on the 23rd inst.

VERY LONG-DISTANCE TELEPHONY.—The *Bulletin Internationale des Téléphones* says that the Belgian Government has arranged with the French and Spanish authorities for experiments in telephony between Brussels and Madrid. It is proposed to use the Dembinski microphone.

TELEGRAMS FOR THE WEST INDIES AND BRITISH GUIANA.—The West India cables interrupted are now repaired, with the exception of those between St. Vincent and Grenada, and between Trinidad and Demerara. Telegraphic communication is therefore restored with all places in the West Indies, except Grenada and Trinidad.

ELECTRICITY FROM SUGAR.—Signor Salvatore Mazza writes from Palermo to *Il Giorno* that he has obtained electric sparks, about 3 centimetres or an inch long and of a colour between blue and fiery yellow, while braying sugar in a copper mortar with a wooden pestle, and that he has seen the phenomenon repeated with copper and iron pestles.

ELECTRICITY AT ASSAB.—*Il Giorno* says that the Societa Industriale Franco-Italiana has sent one of its catalogues to Messedaglia Bey, offering him some electrical apparatus, which may be useful in the Red Sea expeditions, and also prove a source of gratification to the chiefs of friendly tribes. Assab is an Italian settlement on the East Coast of Africa.

ELECTRIC LIGHT AT THE MANSION HOUSE.—On Thursday evening, at the banquet to the masters of the City companies, the new electric light, supplied by the Hammond Electric Light and Power Supply Company, was tested at the Mansion House. The incandescent lamps have been placed in the saloon and the Egyptian Hall, there being 127 in the former, and 142 in the latter.

SKATING BY ELECTRIC LIGHT.—Referring to a recent note as to skating on the lake in the Bois de la Cambre, Brussels, we learn that the lighting was done by the Compagnie Belge et Hollandaise. The fourteen Brush arc lamps were supplied with current by Faure accumulators, charged by the dynamos put down in the Rue de La Loi, in connection with the electric tramway tugs that were to have superseded horses six months ago.

PROGRESS OF ELECTRICITY.—*Il Giorno* is responsible for the following, copied by *l'Electricien*:—A gentleman, travelling with a Yankee, observes: "Grand country, yours; only two centuries ago peopled by savages; what progress and what marvellous results of civilisation!" "Certainly," replied the Yankee, "we have reached such a high degree of civilisation that even in our virgin forests all the rattlesnakes have electric rattles."

THE TELEPHONE IN NEW ZEALAND.—The telephone is getting very popular in New Zealand. There are nearly 1,100 subscribers in the colony. The list continually goes on expanding, and a new annunciator is being prepared for Auckland and another for Wellington, while one has just been supplied to Dunedin. There are also about 100 country stations where the telephone is used, instead of the Morse instrument, for telegraphic purposes.

SOUTH AFRICAN CABLES.—The Eastern Telegraph Company announce the repair of the Eastern and South African Company's Zanzibar-Mozambique cable, thus re-establishing telegraphic communication with the East Coast of Africa, Natal, and the Cape of Good Hope. The Directors have resolved to duplicate this section, and the ss. "Great Northern" is now engaged in sounding, with a view to the selection of a better *route* for the new cable.

ELECTROLYSIS OF PHENOL SOLUTIONS BY CARBON AND PLATINUM.—A. Bertoli and C. Papasogli, continuing their researches into the disaggregation of carbon electrodes in different organic compounds, describe a series of new compounds which they have met with in taking, as electrolytic liquid, a solution of carbolic acid in the hydrate of potash or soda; among others they found an acid $C_7 H_6 O_4$ which belongs to the series of dioxibenzoic acids.

OPTICAL TELEGRAPH.—A system of optical telegraph is being tried, in which an incandescent lamp is placed in the

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middle of a hollow globe made of white cloth, varnished; the lamp being in electrical communication with a battery. When the current passes the globe appears luminous, and is, of course, instantaneously darkened on the current being interrupted. This system has the advantage of giving but little trouble in the transport of apparatus.

THE ELECTRIC LIGHT AT BRADFORD.—The plant recently put down at the office of the *Bradford Observer* consists of one four-unit Crompton dynamo, of the latest improved type of wrought iron, and 75 twenty candle-power Swan incandescent lamps, the power being supplied by an eight horse-power Otto gas engine. The editorial department, the composing room, and the various offices, as well as those on the ground floor, are well and efficiently lighted. The report of Messrs. Byles upon the working of the apparatus is very favourable.

THE AMALGAMATION OF ZINC.—The following directions are given for amalgamating zinc; and, when used for batteries, this must be done carefully:—First, wash the plates in water acidulated with sulphuric acid and then in pure water, when they must be immersed in a solution composed of three-quarter part of mercury, one of nitric acid, and two of muriatic acid. When the mercury is well dispersed two more parts of muriatic acid are to be added. The immersion should not continue for more than about thirty seconds, after which the plates are to be again washed in pure water.

ELECTRIC LIGHT AT TURIN.—Following the example of Aosta, the Turin Municipality has decided to light the Po, Roma, and Garibaldi streets with Edison, Siemens, or Cruto lamps. As the problem of utilising the force of waterfalls and transmitting power to a distance is not yet practically solved, the municipal authorities have made an arrangement with Gaulard and Gibbs, who intend to use the motors which now serve for the Superga railway. The two gas companies will allow the above-mentioned firm to put up in the streets the necessary appliances for arc lighting.

SOUTH OF ENGLAND TELEPHONE COMPANY.—The South of England Telephone Company has received from the Postmaster-General the license, for 27 years, for the establishment and working of telephone exchanges in the district acquired by the above-named Company from the United Telephone Company, viz., the Counties of Northampton, Norfolk, Bedford, Cambridge, Huntingdon, Buckingham, Oxford, Berks, Suffolk, Sussex, and those portions of the counties of Kent, Essex, Surrey, and Hertford which are not included in the Metropolitan area of the United Telephone Company.

LIGHTING OF STRASBURG STATION.—The Elsass-Lottringen Railway Administration decided to adopt electricity for lighting the Strasburg station, although believing it to be more costly than gas, because it would better light up every part, including the sidings. Facts, however, prove that, not only is the electric light no dearer than a corresponding illumination by gas, but that it is even cheaper. The cost of the main installation was 25,154f. (£1,006), and of the supplementary one 8,106f. (£320), while the corresponding prices for gas would be 51,815f. (£2,032), and 9,802f. (£392).

GAS V. ELECTRICITY.—In Lockport, N.Y., a company was formed to introduce electric lighting, and it obtained permission to erect poles and wires in the streets. After this a gas company bought a controlling interest in the electric company, and it was thought this would end the electric light business, but soon after a new company appeared and obtained the privilege to light several streets by electricity in place of gas. Ultimately the gas company commenced to pull down their gas posts and to put up poles for the electric light in Main-street, which right had been given to the new company. A war of words between officers of the two companies ensued, and trouble is expected.

BRUSSELS ELECTRICAL EXHIBITION.—*L'Electricien* says that 1887 is the year fixed for the Brussels Gas-lighting and Electrical Exhibition. A provisional council is appointed, with M. Besme, architect, as president; and several meetings have already been held at the Bourse. Plans, prepared by M. Wybau, the city engineer, utilising for the purposes of the exhibition the Palais du Midi with the adjoining streets and boulevards, have been submitted to the committee, which includes several common councillors, and has already secured the co-operation of the Société Belge d'Electriciens, represented by its president, Professor Rousseau, and the secretaries, M. Charles Mourlon and M. Adolphe Lebégue.

BUCHIN AND TRICOCHE BATTERY.—At the meeting, on 31st January, of the Anciens Elèves des Arts et Métiers, in the Rue Vivienne, Paris, the hall was lighted by three incandescent lamps, two Swan and the other Gérard. Each of the Swan lamps received the current of ten No. 2 bichromate elements; and the Gérard was maintained by two batteries of 25 cells, No. 2 type, connected in multiple arc and filled with bichromate of potash, yielding a luminous intensity of 50 candles. A No. 1 bisulphate of soda battery of four elements supplied the current to a telephone line set up in the hall; and though the circuit remained closed for four hours, communication is said to have been as distinct at the end as at the commencement of the meeting.

ELECTRIC LIGHT AT THE PARIS ELYSEE.—Although the accounts of Central African expeditions have, it is rumoured, been evolved in the vicinity of Fleet-street, and the exciting details of many a British victory, and so forth, had their origin in the same quarter, it is somewhat unusual to find the correspondent of a leading newspaper omitting items of general interest to the public. An official ball was given last week at the Elysée, in Paris, and the salons were successfully lighted by electricity. The innovation seems to have met with universal approval. The temperature, which has hitherto been a source of complaint, was not only bearable but pleasant; and the large conservatory, with its wealth of tropical plants and giant ferns, was bathed in cool light. How was it that M. de Blowitz said nothing of this in his letter to *The Times* describing the Elysée gaities?

GERARD'S INCANDESCENT LAMP.—The new incandescent lamp of M. A. Gérard has two very fine carbon filaments, made by being drawn through a plate, like the carbons of arc lamps, thus ensuring great homogeneity. By suitably proportioning the length of the carbons to their diameter, the consumption of the lamps in volts and amperes may be varied at pleasure, thus obtaining a wide range of luminous power from 2 or 3 candles to 500, or more. The carbons are joined together at their summit by a carbon paste, and are received below by two carbon cylinders of larger diameter, in connection with platinum wires which are soldered to two armatures embracing the lower portion. The lamp is put in place by inserting it into a spring socket, which is fixed to the bottom of the lantern.

PORTABLE ELECTRIC LIGHT APPARATUS.—M. Anatole Gérard has devised portable electric light apparatus for illuminating a building which might contain an explosive atmosphere. The dynamo, to be worked by two men at a crank, and everything else necessary for incandescent lighting are carried on a truck, which remains outside the building, while the lamp is taken in by a fireman, for instance, the light cable

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which contains the two conductors unrolling as he proceeds. The lamps, on the latest Gérard system (as described in another note), are enclosed in lanterns of different forms, some arranged for being carried in the hand, and others fixed to the end of a staff for examining a chimney, a soil-pipe, or a well, the lower end of the staff being pointed, so that it may be stuck in the ground.

HOUSE TO-HOUSE SUPPLY OF CURRENT.—Sig. Meardi has proposed a system for the house-to-house distribution of current, which depends on the following principles:—1. Distribution in series of the conductors to the appliances utilising the current, whether lamps, motors, accumulators, or electro-plating batteries. 2. Subdivision of the intensity of the current among the line conductors in different proportions, the conductors being therefore composed of various materials, but of small section, insulated and completely independent of each other. 3. Differential system of counter-tensions and variable auxiliary resistances, with automatic regulators that may be worked by hand on receiving an oral signal from the tension indicator attached. 4. Utilisation of the series at will, with slow and progressive graduation of the resistances, when the series is put in and out of circuit.

FRIENDLY AID OF THE ELECTRIC LIGHT.—The Brentford Gas Company are building a new gasholder, and, wishing to proceed with all possible speed, applied to Messrs. R. E. Crompton and Co. for a machine arc light. The electric light accordingly came to the rescue, and a brilliant arc of about 4,000 candle-power now illuminates the interior of the gasholder, and enables the work to be carried on with great speed at all hours. The engineer states that "the light answers admirably," and they are enabled to get through the work in half the time they would have done without it. This rather novel application of electricity to aid in the manufacture of gas should be a lesson to our opponents that the electric light in some instances can be a valuable auxiliary to gas itself. It also appears that the Brentford Gas Company are more enterprising than many of their neighbours.

ATTRACTION BETWEEN SUBSTANCES IN SOLUTION AND BODIES IMMERSED IN THE SOLUTION.—In a recent note, we referred to the experiments of M. Toulet, which show that, when a salt is dissolved in a liquid, and the solid body is immersed in the solution, there is an attraction between the salt and the solid body, independently of chemical action. M. Thoulet attributes to this attraction, which is proportional to the surface of the immersed body, the following phenomena:—(1) Impurity of most chemical precipitates, especially those that are gelatinous; (2) Diminution of the concentration in saline solutions discoloured by animal black, or alcaloids, and also the action of glutinous substances, such as blood and albumen, used for clarifying liquids; (3) purification of surface water and sewage; (4) the fact that clay, remaining indefinitely suspended in distilled water, is quickly precipitated in water containing salts in solution.

LA REINE DES BELGES, ELECTRICIENNE.—The love of music by the Queen of the Belgians is second only to Her Majesty's fondness for horses. The former passion was lately gratified (as recorded in *The Electrician*) by the transmission of Gounod's "Faust" from the Brussels "Monnaie," or Opera House, to the royal châlet at Ostend, where the Queen was able to enjoy the opera without quitting her boudoir. This feat evidently inspired the royal auditor with a profound respect for electrical science; and Her Majesty set about studying its principles, being aided in the task by M. van Rysselberghe, the inventor of simultaneous telegraphy and telephony, and Mr. Charles Mourlon, who successfully applied it to the Belgian telegraph lines. Such progress has been made by the august pupil that already the title of "*électricienne*" has been conferred by common consent, while the professors have been rewarded by Her Majesty with valuable presents for their share in the result.

DETERMINATION OF THE OHM.—In a recent note before the French Academy of Science, M. Mascart remarks that all methods give a greater length than 106 centimetres of mercury, except that of neutralisation (*amortissement*), while this method has, on the contrary, always given a lower number; and he inquires if a more complete interpretation of the theory might not furnish an explanation of this difference. It results from his researches that the correction to be made in the approximate calculation of the resistance, taking into account the coefficient of self-induction, should be somewhat less than that usually made, and that the strong induced currents should give the bar, in a transverse direction, a temporary magnetisation, which must be taken into consideration. These two corrections contribute to increase the value of the intensity of resistance hitherto found by the method of neutralisation, which fact explains why the figures which it gives have always been found under the mark.

CURATIVE ELECTRICITY AND CONDENSERS.—In a recent communication to the Société des Electriciens, Paris, Dr. Boudet established the fact that the method of excitation by the discharge of the condenser, employed in physiological laboratories, and introduced by him a few years ago into therapeutical practice, is the only one which has hitherto given exact results always comparable with one another. It is similar to the excitation by the galvanic shock, but possesses over the latter the advantage of not irritating the skin by its chemical effects. The condenser should be preferred to the induction coil whenever it is not required merely to awaken the sensibility of the skin, and when it is desired to take into account the excitation employed, because, with coils, induced currents are used irrationally, and without seeking to appreciate their mechanical value. Dr. Boudet concludes by observing that, as electricity is *par excellence* the science of progress, the physician who employs electric currents should, more than any other, avoid lagging behind.

MUSIC AND THE TELEPHONE.—In connection with a concert given at Inverness last week, an experiment was made by the National Telephone Company. A wire connected the hall with the Telephone Exchange office, and several subscribers, in different parts of the town, were placed in communication. In the office itself the concert could be heard with singular distinctness, and even when the sound was distributed through the various connecting wires, the listeners at a distance could distinguish and enjoy the entertainment in the hall. The instrumental music and the choruses were heard most distinctly at a distance of over a mile, while some of the vocal solos were quite distinguishable. Two ordinary Blake transmitters were used, mounted on brass stands about 6ft. above each side of the platform, and connected in multiple arc. In connection with the transmitters, Bennett's iron cells were used, each transmitter having two of what are called "red" type connected in multiple arc. An ordinary G.P. covered No. 18 copper conductor was used to connect the instruments with about a dozen of the company's subscribers.

BROMINE AS A DEPOLARISING AGENT.—The depolarisation of the negative pole in an electric cell by the direct combination of the hydrogen evolved with oxygen produced by the decomposition of higher oxides or their derivations suggested to Mr. Koosen the use of bromine as one of the elements of a

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constant galvanic cell of strong E.M.F. The cell thus constructed consists of a glass vessel, narrowed at the lower extremity, into which is poured the bromine; on this rests a plate of clay, on which is placed a clay cell containing an amalgamated zinc cylinder. A platinum wire passes through the clay plate into the bromine. To complete the cell, the upper part of the apparatus is filled with dilute sulphuric acid, covered by a thin layer of petroleum to prevent the diffusion of the bromine into the atmosphere. The E.M.F. of the combination, zinc, dilute sulphuric acid, bromine solution, platinum, is 1·9 volt; by substituting carbon for platinum, this value is increased. Its internal resistance is, however, greater than Grove's or Bunsen's cell, but has the advantage of being constant for several months.

ELECTRICAL MEASURE.—It is said that by means of the new instrument of M. Louis Maiche, the "michrohm-mètre," infinitesmal resistances may be measured with perfect exactitude. The instrument consists of a horizontal magnetised needle, which is placed between two bobbins of absolutely equal resistance, their coils being parallel. The coils are wound in directions reverse to each other, so that their action upon the needle is neutralised, and it rests immobile. The resistance to be measured is placed in the circuit of one of the coils; this reduces the tension of the current flowing in that coil and diminishes its controlling influence upon the needle, which deviates from its former position. Equilibrium is then restored by adjusting the stronger coil with a micrometer screw, which is graduated and indicates the value of the displacement of the second bobbin. It is claimed that the action of the instrument is both simple and exact; not only eliminating all the possibilities of error due to the imperfect contacts sometimes found in the Wheatstone bridge, but registering with accuracy such resistances as $\frac{1}{2000}$ of an ohm.

A SCIENTIFIC SUICIDE.—Of all the applications of electricity, there are but few which do not add to the general comfort, and tend to promote the welfare of our fellow creatures. Unscrupulous individuals have, from time to time, employed that useful agent for the furtherance of their designs upon human life and property, and others, not electricians, have dilated upon its peculiar fitness for the office of public executioner. *O tempora, O mores!* However, if no one puts electricity to a baser use than M. Paul Thiébault, who investigated the properties of high tension currents, with some inconvenience to himself, the world would not have to mourn the loss of any of those qualities which, in man, tend to ameliorate the condition of mankind. M. Paul Thiébault, aged 30 years, married, without children, has been struck dead by the current generated by the electric light apparatus at the works of M. Chertemps, in Paris. The result of the inquest showed that the deceased had entered the room on the first floor where the apparatus was at work, and had voluntarily and deliberately taken hold of the conducting wires; receiving a shock that killed him instantaneously.

ELECTRIC LIGHT WANTED AT EXETER.—The Corporation of Exeter purpose lighting by electricity an asylum now in course of erection. The asylum will be constructed to accommodate at present 300 patients, with provision for extension. Particulars of its dimensions and the ground plan of the building can be seen at the office of the architect, Mr. R. Stark Wilkinson, 14, Furnival's-inn, London, or Post Office-chambers, Queen-street, Exeter. Schemes and specifications are wanted for lighting the building; and tenders for (*a*) the first cost of installation, and (*b*) maintaining and working the scheme, recommended for a term of seven years, at a fixed sum per annum, are invited, but all tenders for installation only must state the probable annual cost of maintenance and working. Schemes and specifications must be accompanied by a tender for carrying out the work. The corporation will not pledge themselves to accept any tender, and they reserve the right to accept a tender for installation while they may reject the tender for maintenance and working; and no payment will be made for schemes or tenders. Sealed tenders must be sent to the town clerk, No. 15, Bedford-circus, Exeter, on or before the 1st May.

ELECTRIC LIGHTING CENTRAL STATION.—The installation at the Grosvenor Gallery is of far larger proportions than originally contemplated. Steam power of over 600 indicated horse-power will be supplied, while the dynamos made by Messrs. Siemens Bros. and Co. are the largest yet turned out by that firm. An excavation of nearly 600 square feet is being made under the Grosvenor-buildings, and in this space the machinery will be placed. Messrs. Gaulard and Gibbs's new type of secondary generators will be employed. About 5,000 lamps are being let out at a rental which, while paying the company who have taken the matter in hand, is accepted by those who desire the new illuminant. A temporary installation in Bond-street is now supplying about 250 incandescent lamps upon the secondary generator system in order to test its capabilities, and, so far, the result has been more than satisfactory; the current being perfectly under control. The whole of the arrangements, engineering and electrical, are being carried out on behalf of Sir Coutts Lindsay and Co. by Messrs. Mackenzie and Brougham, of 15, Great George-street, Westminster, who are the engineers to the undertaking. The work is to be completed in two or three months.

ELECTRIC SEARCH BOAT.—A craft, propelled by electricity, swift, silent, invisible in the dark, and easily managed by one man, undoubtedly possesses great advantages over the noisy steam-launch for the purpose of patrolling the Thames; and Messrs. Stevenson and Smith are to be commended, not only for their idea, but for the efficient means they have taken to put that idea before the authorities and the public. With the assistance of the Electrical Power Storage Company and Mr. Reckenzaun, a boat has been fitted up with a number of accumulators containing electricity sufficient to propel it at a considerable speed for several hours, and to supply a powerful search-light ready for instant use. A trial of the craft in question took place the other evening, and the experiment was to be tried again on the evening of Thursday, the 26th. The boat is 25ft. in length, with a beam of 5ft. 6in., and contains in a box running fore and aft 50 accumulators, weighing 40lb. each, which hold sufficient electricity to propel the boat at a speed of about eight miles an hour for four hours, or, if the arc light be used the whole time, for about an hour and a half less. This lamp, which is placed in the head of the boat, is of 3,000-candle-power, and its rays can be easily turned in various directions. By its aid objects on the water could be discerned at a distance of from 200 to 300 yards.

THE TELEGRAPH AND THE WAR.—The statement which recently came to hand from the Soudan that the Mahdi had executed two spies in consequence of information as to their doings having reached him through English newspapers, has again drawn attention to the mischievous uses to which the telegraph may be subjected at the hands of indiscreet newspaper correspondents. It is stated on good authority that whatever is telegraphed from the Soudan to England finds its way back again to the Mahdi's emissaries in a remarkably short space of time, and the execution of these two useful agents of ours seems to confirm the assertion. We had understood that Lord Wolseley, more than any other English general, was particularly watchful in

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his censorship of "Our Special Correspondents'" telegrams; but either his vigilance has slackened or the newspaper men somehow manage to elude it. Otherwise there would not have appeared in print at the beginning of this week a description of Captain Wardrop's exploit, the publication of which, say next year, would have redounded to his credit not less than its trumpeting just now. It is probably the last time that trick can be played; and, what is perhaps of more consequence to the safety of the little band at Abu Klea, the Arabs now know that the supposed army of relief was not an army at all, and may renew their attacks. It is such gross and utterly needless revelations as these which bring the telegraph into discredit.

THE ELECTRIC LIGHT.—The installation at the Ferney Mills, Todmorden, comprising a 21-unit Crompton wrought-iron machine and 268 lamps, seems to give unqualified satisfaction. The light has been in operation for about three months, and is thus favourably reported upon by Mr. Crabtree, the owner of the mills in question:—"With respect to the cost of working—Power: We had plenty of surplus power, and as the result of an extremely careful test, made under conditions as nearly as possible parallel, we found that in four hours' working of the whole 268 lamps we only used 1½cwt. more coal than in four hours without the light, or less for power than 1½d. per hour for the whole 268 lights. Dynamo: This does not appear to be in any way depreciated; it seems as good as when it came, and the brushes are very little worn; it would seem as if the cost of renewals would be small indeed. Attendance: Including oiling, stopping and starting the dynamo, and the weekly cleaning of lamps, we find that less time is taken up than would be with gas." Mr. Barker, of Hebden Bridge, also reports that:—"The electric lighting plant (Crompton-Bürgin dynamo and Swan incandescent lamps) fitted in our clothing factory at May Royd is giving every satisfaction. We get the motive power from an ordinary breast waterwheel, which produces a very steady light. One of our warehousemen attends to the whole plant, spending on an average under thirty minutes per day. We may say that, although the premises are rather extensive and that we have 100 lamps, we can light the whole in less than two minutes from opening the doors."

ELECTRICAL RESISTANCE OF BISMUTH.—In a note to the French Academy of Science, M. Hurion gave an account of his experiments for determining the fact pointed out by Professor Righi, that the electrical resistance of bismuth increases when it is placed in a magnetic field. He asks if the variation of resistance noticed does not depend on the mechanical action exerted by the electro-magnet on the bismuth, and he seeks to estimate this action. A small bismuth plate, carried by a light wood frame with concave mirror, was suspended by a platinum wire. A copper ball, attached to the under side of the wood frame, served to stretch the wire, the upper part of which might be twisted to any angle, capable of being read correct, within a second, on a graduated circle. At the height of the mirror was a transparent and divided rule, on which was thrown a reflection, permitting of estimating, with the same nearness of approximation, the angular displacement of the wood frame. The bismuth plate, placed between the poles of the electro-magnet, was brought to equilibrium without any torsion of the wire, and then displaced to a certain angle, when the torsion corresponding to the angle was measured. Experience has shown that, for small angles, the torsion was proportional to the displacement, the ratio of the first quantity to the second being taken as a measure of the mechanical action sought. The experiments proved that the variation of resistance is appreciably proportional to the mechanical action exerted by the electro-magnet on the bismuth plate, while the curves of the two quantities present the greatest analogy. Professor Righi, who has devoted much attention to the changes which occur in the electrical resistance of bismuth at different temperatures, obtained a series of precise results. According to him, the electrical resistance of the bismuth of commerce is increased by the action of heat between certain limits of temperature and diminished between others. The curve of this variation, and of the different results obtained, are stated at length in the memoir published at Rome. The professor has also studied the influence of magnesium on this substance, and has found that the resistance increases under the influence of magnetism as much in pure bismuth as in the bismuth of commerce.

MODIFICATION IN THE SPARK OF INDUCTION COILS.—In a paper lately brought before the French Academy, M. Eugéne Demarçay points out certain modifications with the induction coil, for rendering its use easier and more practical in spectral analysis. The source of light universally used is the spark of very high potential, from a coil with a long and fine induction wire. This special construction is necessary in the case of M. Lecocq's experiments, owing to the fact that the liquid opposes a resistance impossible to overcome in the case of sparks with a slight potential. Employed in its original state this spark does not afford spectra capable of being utilised for bodies when it is desirable that they should have no appreciable chemical reaction. Moreover, the great part of those who have wished to obtain bands for these bodies have had recourse to the same induction coil by adding to it a condensing battery of greater or less power. Besides, it cannot be dispensed with when metallic electrodes of short interpolar distances are used to produce spectra, the spark otherwise becoming quite insignificant. But a considerable drawback to this process arises from the presence in the *spectrum* of secondary bands from the air and of bands from the electrodes. The *spectrum* of the air especially has a brightness much greater than that of the metallic bands present. This drawback, added to the separation necessitated by the *spectrum* of the electrodes, renders long and difficult an examination which, if it is not rapid and simple, is without practical value for the chemist. All these difficulties disappear at once, and a spark is obtained which gives no trace of secondary bands of the air and rarely slight traces of nebulous primary bands of nitrogen and bands of the electrodes, by using the spark of a coil with thick and short induction wire. This spark has a temperature sufficiently high to easily give *spectra* of all the elements known. The coil constructed for this purpose yields a spark of 5 millimetres only, under the action of a battery of 6 or 9 bichromate elements (zincs, 10 by 16 centimetres), two or three in *surface* and three in series. The coil has 115 centimetres in internal diameter, and a length of 23 centimetres. The induction wire, 1 millimetre in diameter, weighs 1·32 kilogramme, and is wound on two ranges. The induced wire, 1 millimetre in diameter, weighs 3·4 kilogrammes. The bundle of soft iron wire, 27 millimetres in diameter, weighs 680 grammes. Lastly, the condenser of the inducing current is threefold that of the condenser usually placed on such coils. It should still be insufficient, because the spark of the extra current is very appreciable. The spark produced is 5 millimetres long; and its *aureola*, at least 3 millimetres for 6 elements, is almost silent, and becomes brilliant when sufficiently shortened. It gives with brilliancy, especially when short, the *spectrum* of the electrodes and traces, scarcely visible, of the primary nebulous bands of the air, which even disappear entirely in most cases.

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ALTERNATING CURRENTS.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 287.)

CONDENSER.

In applying the geometrical method to the representation of the effects upon the carrying power of a circuit of electric capacity it will be necessary to bear in mind carefully what is meant by capacity. An arrangement is said to possess capacity when the arrival and accumulation of a certain finite quantity of electricity is necessary before it can exhibit a rise in potential. If the rise in the potential is proportional to the net arrival of electricity, the capacity of the condenser is said to be constant, and is measured by that amount of electricity necessary for a rise of potential of a unit amount. It has been denied that a voltameter is a condenser, but without justice. The arrival and accumulation of electricity is necessary before the electrodes of the voltameter exhibit difference of potential. When this takes place it is accompanied, not perhaps by what is sometimes understood as a static charge, but by a decomposition of the fluid, and an annexation, incipient or otherwise, by the electrodes of the products of the electrolysis. In an incipient condition, with which in the question of alternations we should have to deal, it is not certain how the quantity of electricity which has reached the voltameter is connected with the difference of potential exhibited by the electrodes. That is to say, the condenser of this form may not have a constant capacity, and therefore might disturb the harmonic nature of the alternations, even when the variation of the impressed electromotive force was truly harmonic. But with the more usual form of condenser, where there exists a constant capacity, there will be, indeed, upon its introduction into the system, a rearrangement of the values of the current in different parts, but each will remain harmonic in character.

Suppose the straight lines A B, B C, C D, &c., being the consecutive sides of an unclosed polygon, represent the values of *currents* conveying electricity harmonically to and from a point, with the same period of variation.

Then, since the rate of arrival of electricity is represented at any instant by the sum of the projections of the individual lines upon some fixed line, and the sum of such projections is equal to the projection of the line joining A D, the extreme points, therefore the arrival of electricity will be that due to *one* current of the value A D.

Thus, however many harmonic currents of the same period are flowing into and out of a condenser, and whatever their differences of phase, their effect in charging that condenser will be that due to *one harmonic current* of the same period, and in a certain determinate phase as regards the actual currents. This current may be called the effective current.

It will be necessary to consider, therefore, the effect upon a condenser of constant capacity of the arrival of electricity at a rate undergoing harmonic variation, for that rate is the effective current.

While the current is positive the charge is always increasing; and, *vice versâ*, the charge of the condenser is always decreasing when the current flows away from the condenser. Hence the charge will be greatest when the current is changing from positive to negative through the value zero, and least when the current is changing from negative to positive through the value zero.

Let us take this latter point to start from, and consider what the accumulation of electricity will be in a given time t. If T is half the period, the angle through which the line representing the current will revolve in time t is equal $t\frac{\pi}{T}$. Call this angle α. Let θ represent any angle which the line has traversed between zero and α by a given point of time.

Then if c is the maximum value of the current, $c \sin\theta$ will be its value at the particular point of time considered. Now, supposing we knew the average value of this current between the values of θ, zero and α, we should only have to multiply this average value into the time t to find the value of the electrical accumulation. The factor c is constant, and therefore the accumulation depends upon the average value of $\sin\theta$ between 0 and α.

The following subsidiary proposition is a mode of finding the value required without the use of the integral calculus.

PROPOSITION II.

To find the average value of $\sin\theta$ and $\cos\theta$ when θ varies from 0 to α uniformly

Let $S(\alpha)$, $C(\alpha)$, represent respectively the average values of $\sin\theta$ and $\cos\theta$, when θ varies uniformly from 0 to α.

Now, the cosine of any angle between 0 and α may be expressed by $\cos\left(\frac{\alpha}{2}+\phi\right)$ or $\cos\left(\frac{\alpha}{2}-\phi\right)$; where ϕ may have all values from 0 to $\frac{\alpha}{2}$.

Therefore all the values of θ may be grouped into a number of pairs, represented by $\left(\frac{\alpha}{2}+\phi\right)$ and $\left(\frac{\alpha}{2}-\phi\right)$; where ϕ varies from 0 to $\frac{\alpha}{2}$.

Now, $$\cos\left(\frac{\alpha}{2}+\phi\right)=\cos\frac{\alpha}{2}\cos\phi-\sin\frac{\alpha}{2}\sin\phi$$

and $$\cos\left(\frac{\alpha}{2}-\phi\right)=\cos\frac{\alpha}{2}\cos\phi+\sin\frac{\alpha}{2}\sin\phi.$$

Therefore, the average value of the pair of cosines, $\cos\left(\frac{\alpha}{2}+\phi\right)$ and $\cos\left(\frac{\alpha}{2}-\phi\right)$ is $\cos\frac{\alpha}{2}\cos\phi$.

Thus the average value of $\cos\theta$, where θ varies from 0 to α uniformly, depends upon the average value of $\cos\phi$, where ϕ varies uniformly from 0 to $\frac{\alpha}{2}$, as in the following expression:—

$$C(\alpha)=\cos\frac{\alpha}{2}C\left(\frac{\alpha}{2}\right).$$

Similarly $$C\left(\frac{\alpha}{2}\right)=\cos\frac{\alpha}{4}C\left(\frac{\alpha}{4}\right).$$

Therefore $$C(\alpha)=\cos\frac{\alpha}{2}\cos\frac{\alpha}{4}\cos\frac{\alpha}{8}\ldots\ldots\cos\frac{\alpha}{2^n}C\left(\frac{\alpha}{2^n}\right).$$

The angle $\frac{\alpha}{2^n}$ becomes indefinitely small when n is made infinitely large, and evidently the average value of the cosine of a very small angle approaches unity, therefore $C\left(\frac{\alpha}{2^n}\right)$ is equal to unity when n is made infinitely great.

Therefore $$C(\alpha)=\cos\frac{\alpha}{2}\cos\frac{\alpha}{4}\cos\frac{\alpha}{8}\ldots.\ \textit{ad infinitum}.$$

But by ordinary trigonometry

$$\sin\alpha=2\cos\frac{\alpha}{2}.\sin\frac{\alpha}{2}$$

$$=2^2\cos\frac{\alpha}{2}.\cos\frac{\alpha}{4}.\sin\frac{\alpha}{4}$$

$$=\alpha.\frac{2^n}{\alpha}.\cos\frac{\alpha}{2}\cos\frac{\alpha}{4}\cos\frac{\alpha}{8}\ldots\ldots\cos\frac{\alpha}{2^n}\sin\frac{\alpha}{2^n}$$

$$=\alpha.\cos\frac{\alpha}{2}\cos\frac{\alpha}{4}\cos\frac{\alpha}{8}\ldots.\cos\frac{\alpha}{2^n}\left(\frac{\sin\frac{\alpha}{2^n}}{\frac{\alpha}{2^n}}\right)$$

and when n is infinitely larger,

$$\frac{\sin\frac{\alpha}{2^n}}{\frac{\alpha}{2^n}}=1.$$

Therefore, $$\sin\alpha=\alpha\cos\frac{\alpha}{2}\cos\frac{\alpha}{4}\cos\frac{\alpha}{8}\ldots\ldots\ \textit{ad infinitum},$$

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and hence

$$C(a) = \frac{\sin a}{a} \quad \ldots\ldots\ldots\ldots \quad (\alpha)$$

or the average value of cos θ, when θ varies uniformly between 0 and a, is $\frac{\sin a}{a}$.

Similarly

$$\sin\left(\frac{a}{2} + \phi\right) = \sin\frac{a}{2}\cos\phi + \cos\frac{a}{2}\sin\phi,$$

and

$$\sin\left(\frac{a}{2} - \phi\right) = \sin\frac{a}{2}\cos\phi - \cos\frac{a}{2}\sin\phi.$$

Therefore, the average value of the pair of sines, $\sin\left(\frac{a}{2}+\phi\right)$ and $\sin\left(\frac{a}{2}-\phi\right)$ is $\sin\frac{a}{2}\cos\phi$.

Thus the average value of $\sin\theta$, when θ varies from 0 to a uniformly, depends upon the average value cos ϕ, where ϕ varies from 0 to $\frac{a}{2}$, as in the following expression :—

$$S(a) = \sin\frac{a}{2} C\left(\frac{a}{2}\right).$$

But by the former portion of the proposition the value of $C\left(\frac{a}{2}\right)$ has already been determined (α) to be

$$\frac{\sin\frac{a}{2}}{\frac{a}{2}}$$

Therefore

$$S(a) = \frac{\sin^2\frac{a}{2}}{\frac{a}{2}} = \frac{1-\cos a}{a}; \quad \ldots\ldots \quad (\beta)$$

that is to say, the average value of $\sin\theta$, when θ varies from 0 to a, is

$$\frac{1-\cos a}{a}.$$

We can now deal with the electric problem, for the supply of electricity given by the harmonic current in a time t dating from the zero value of the current will be $tc\,S\left(\frac{t\pi}{T}\right)$

$$\text{or } tc \times \frac{1-\cos\frac{t\pi}{T}}{\frac{t\pi}{T}} = \frac{Tc}{\pi}\left(1-\cos\frac{t\pi}{T}\right) = \frac{Tc}{\pi} - \frac{Tc}{\pi}\sin\left(\frac{\pi}{2} - \frac{t\pi}{T}\right) \quad \ldots \quad (\gamma)$$

and the total supply during one half period is therefore equal to $\frac{2Tc}{\pi}$, which is the value of the above expression when t is equal to T. During the second half period this quantity of electricity is abstracted.

During the first quarter period the supply will be $\frac{Tc}{\pi}$, or half the entire quantity, and as it is convenient always to measure from a mean value of any harmonically varying magnitude, we may consider $\frac{Tc}{\pi}$ to be the addition or withdrawal of electricity in any of the quarter periods, to or from the mean value.

The expression (γ) shows that the variation in the supply is harmonic, and differs by a quarter period in phase from that of the current in the direction of retardation.

Hence, if the condenser be one whose capacity is constant the potential difference of its plates will undergo harmonic variation, and in a diagram of electromotive forces will be drawn at right angles to any line which is in the same phase as the effective current into the condenser, in the direction of retardation. If C is the capacity of the condenser, the amplitude of the difference of potential of its plates will be $\frac{1}{C}\frac{Tc}{\pi}$ which E.M.F. will occur when the effective current is changing its direction.

We shall next consider the effect of connecting two points of a circuit with the plates of a condenser.

(TO BE CONTINUED.)

MATHER AND PLATT'S PATENT GEAR.

FOR DRIVING DYNAMOS ON BOARD SHIP, AND IN OTHER CASES WHERE THE SPACE IS CONFINED.

The first sketch shows an arrangement for driving a dynamo by helical wheel gearing.

The engine is one of Mather and Platt's usual double cylinder diagonal engines, with cylinders 8in. diameter by 10in. stroke. As will be seen, the bed is of a rigid form, and suitable for running at a high speed with great steadiness. The crank is of the ordinary double sweep form, and the crosshead and slides are cylindrical. The engine is fitted with the well-known Mather and Platt patent metallic piston. The valves are of the slide valve type, and the engine is regulated by a Pickering governor attached to the steam supply pipe, and driven from the crank shaft by a pair of beveled wheels.

The engine has long brass bearings, the crank shaft bearing on the driving side being made extra long.

The fly-wheel is formed into an internal spur wheel with double helical teeth, the boss of the wheel being turned and let into the crank shaft bearing, which is bored out to receive it. By this means the strain on the crank shaft is one of torsion only, and the wheels are more rigid and kept in their proper relative positions, so that the teeth are always in full gear. This wheel gears with a pinion keyed on a shaft carried through the engine bed. This shaft is coupled direct to the dynamo shaft by means of a flexible coupling. It will thus be seen that any slight irregularity or jar in the engine or first pair of wheels is lost in the shaft and coupling before reaching the revolving armature of the dynamo, which is of the greatest importance on account of its weight and speed, and from the fact that any springing of the shaft, however small, is intensified by the unequal magnetic stresses which are at once brought into action. The wheels of the engine and dynamo are in the proportion of 6 to 1, the former making 175 revolutions per minute.

This method of driving possesses great and obvious advantages over any kind of friction gear. All devices for driving by friction gear necessitate more or less delicate and elaborate arrangements for regulating the pressure between the friction surface, and these require constant attention and adjustment in order to follow up the wear. There is also the loss of power in friction, which even with plane surfaces is very considerable, and still greater when V grooves are employed. In an internal wheel the friction is less than in ordinary spur gearing, as the stresses are more nearly exactly tangential to the pitch line of the wheels. There is very little wear in the wheels, and no parts requiring replacement, which is necessarily the case with the friction pinion. When the wheels are once set they require no further adjustment or attention. By using double helical teeth in connection with an internal wheel the number of teeth in gear at any instant is increased, so that a finer pitch can be used, which reduces the noise so as to be almost unnoticeable.

The engine is shown in the drawing driving one of Mather and Platt's new compound wound dynamos for 150-200 twenty candle-power lamps, 100 volts E.M.F. at 1,050 revolutions per minute, of the same type as above described.

The second sketch illustrates the same sytem of driving applied to the same dynamo, the engine in this case being one of Mather and Platt's single cylinder oblique engines. The cylinder is 10in. diameter by 12in. stroke. The wheels are the same proportion as before, viz., 6 to 1, and the engine makes 175 revolutions per minute. The crank shaft is of the best hammered scrap, and carried in long adjustable brass

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bearings. The connecting rod is also of wrought iron, having adjustable brasses at both ends, and adjusted to the crosshead by a steel pin. The slide is of cast iron, and bored to suit the circular cross head. The engine is fitted with a Mather and Platt patent piston, with steel piston rod, and the regulation is effected by a Pickering governor, driven by a strap from the crank shaft.

The driving is effected through a shaft and flexible coupling, just as in the previous arrangement.

The third sketch illustrates an arrangement of short-belt driving applied to the same dynamo and diagonal engine above described. The engine is just as before, except that in the place of the helical wheel on the engine the fly-wheel is turned suitable for belt driving.

The proportion of the wheels and the speed of the engine are the same as before.

In order to give the strap more grip on the pulley of the dynamo, by giving it more surface and at the same time taking up the sag in the belt, a very effective arrangement is used, and which is clearly shown in the drawings. This consists of an arm which swivels on the filbore of the dynamo shaft, and at the end carries a pulley riding loose on a stud. The lower end of the arm is formed into a wheel quadrant, which gears into a worm carried on a spindle at the end of the bed of the dynamo. By turning a hand-wheel keyed on the end of the worm spindle the arm, and with it the pulley, is raised or lowered, and thus the strap wrapped less or more round the pulley as required, giving a neat and effective strap driving in a small space. It is evident that a long strap is unnecessary, and it is obvious that a great saving is effected in belting alone. For in this case we have a belt which may be less than half the length of a belt as generally used doing the same work, but with the advantage of putting less strain on the driving side of the strap, and also on the dynamo shaft, by giving more pulley surface to the belt.

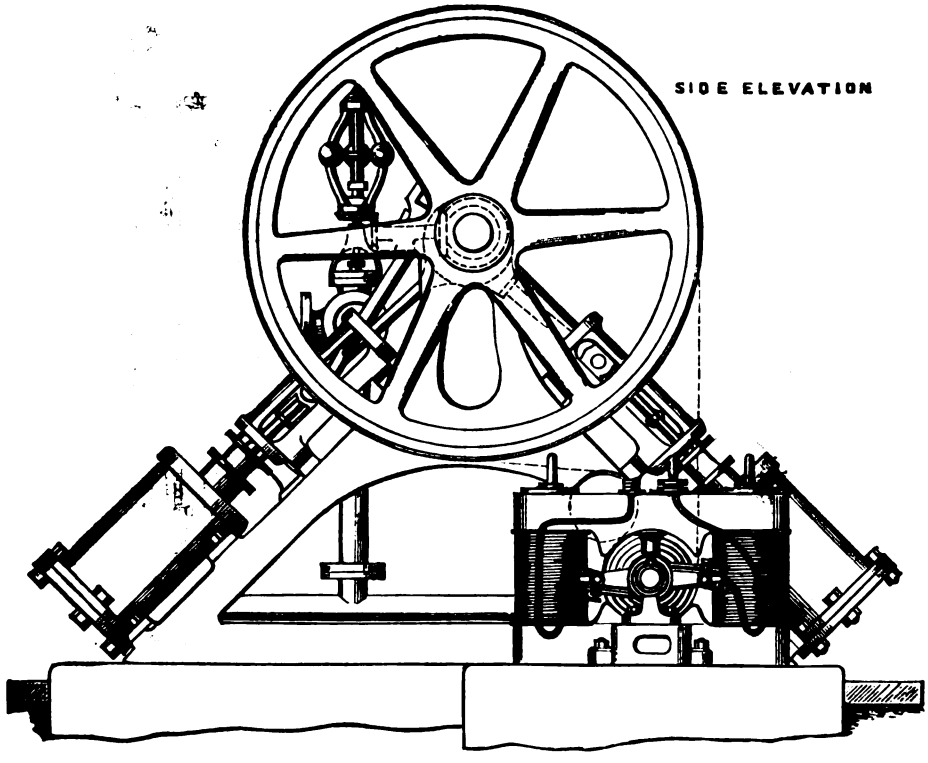

FIG. 1.

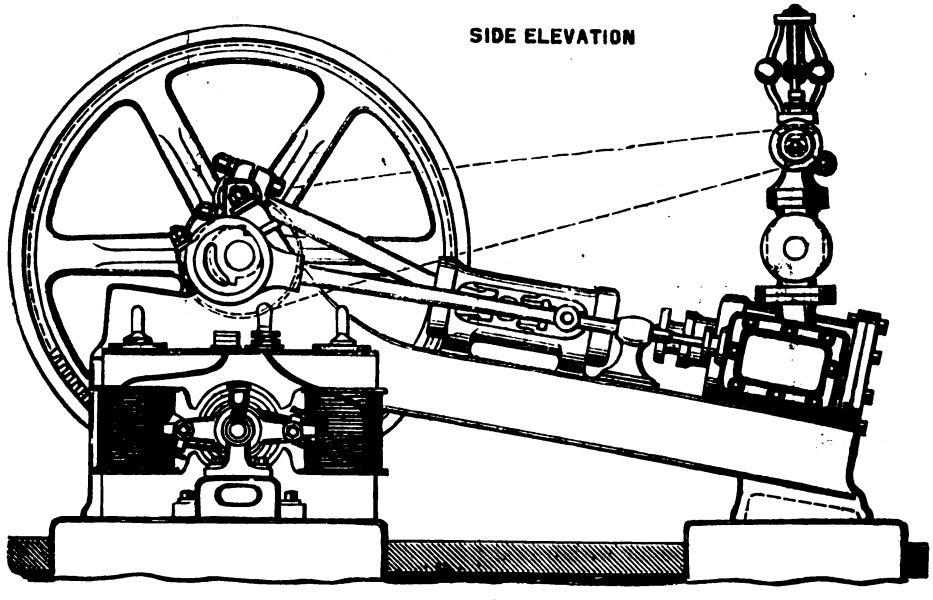

FIG 2

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The fourth drawing shows the above arrangement of belt-driving applied to the same dynamo, but using the single cylinder engine before described in place of the diagonal engine. The advantages of these methods of driving are not confined to ship lighting. In mills and workshops it is often desirable to place the dynamo in the engine room, so that it may require no further attendance than from the man in charge of the main engines. The space is usually in such cases very confined, excluding the possibility of driving by a long belt. The method last described has been very effectively employed by Messrs. Mather and Platt in the installation in connection with the Theatre Royal and Comedy Theatre in Manchester for driving two 250-lamp Edison-Hopkinson dynamos. It may also be advantageously used with gas engines for house lighting, as it enables the engine and dynamo to be fixed on a single bed plate.

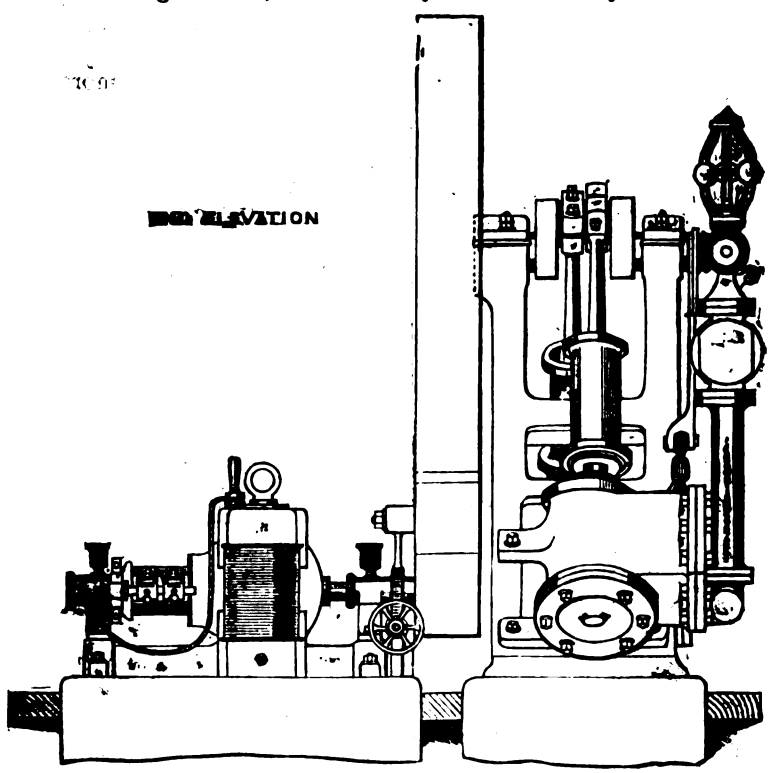

FIG. 3.

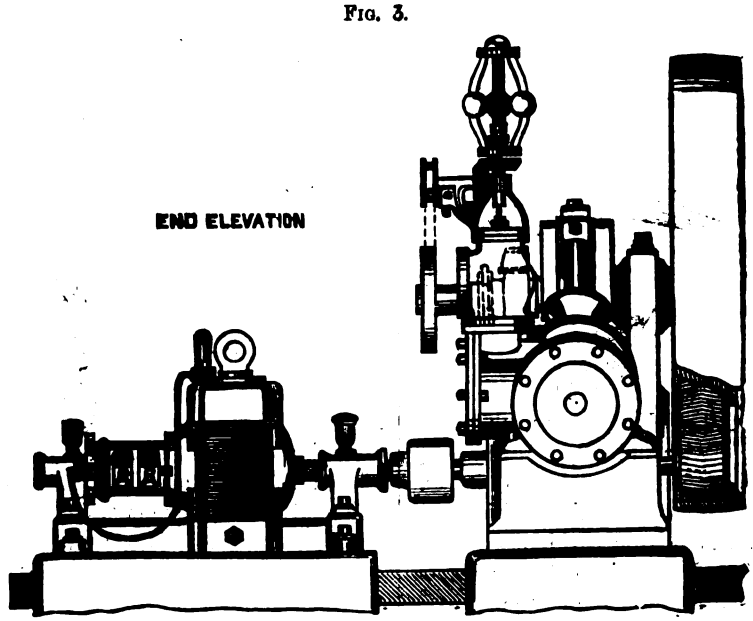

FIG. 4.

ELECTRO-CHEMICAL EQUIVALENTS.

M. E. Hospitalier terminates an article in *L'Electricien* on electro-chemical equivalents, as follows:—Faraday's and Thomson's laws sum up all the facts at present known about electrolysis. Let us be content with them and apply them, without introducing the notion of *thermic characteristics* and *thermo-electric coefficients*, the least inconvenience of which is to introduce non-homogeneous equations into the calculation, thus rendering verification impossible. We have already deprecated this view of electro-chemical phenomena, and protested against expressing in *calories* the electromotive force of batteries, which introduces a confusion of ideas to be combated so long as it exists. A *calorie* is of the same nature as a unit of work, and can therefore not be compared with electromotive force; and it is no more correct to express the latter in *calories* than to speak of an intensity of current being equal to a quantity of electricity, or a unit of work to one of power, as has been done by the reformer of Faraday's and Thomson's laws.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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THE POSTMASTER-GENERAL ON GAMBLING.

The present Government has been eulogised as a Ministry composed of all the virtues, and until recently we all believed it. Perhaps it was owing to the consciousness of something lacking in their title to this encomium, rather than to any scepticism on the part of the British public, that a couple of brand new virtues to the round dozen which illuminated the councils in Downing-street has lately been added. Any way, one noble lord has come in who holds convenient views about Providence and the fall of Khartoum; whilst the new Postmaster-General carries with him an exemplary horror of gambling. Neither of these gentlemen is expected to button-hole his colleagues on the subject of his favourite cult. Were this the case, Providence, in connection with the contingent fall of Berber into British hands, might be an inconvenient topic for some of the graver Ministers; and for some others of a gayer turn of mind Mr. Shaw-Lefevre's notions about betting might be deemed out of place. The beauty of the arrangement, as a whole, it will be seen, is that the virtues are represented not individually but collectively, without imposing an irksome quantity upon any one in particular.

Mr. Shaw-Lefevre, we say, has expressed a horror of gambling. We do not mean of gambling in politics—a virtue which for aught we know has yet to be adequately individualised in the Cabinet circle—but gambling at cards and on horse races. No sooner did he assume his new rank than the public were informed through the newspapers that the new Postmaster-General had issued an edict against gambling—nay more, had demonstrated his sincerity by summarily discharging one postal officer and reducing several subordinates for holding views on this subject which were considered heterodox. It is due to him to remark that he "has felt constrained" to do this; and we all know that from an orthodox point of view when we "feel constrained" to do this or that, how pained we are to have to do it, and how proud of having overcome our reluctance. We do not wish to say a word in defence of the culprits, whose offence seems to have been that they played at cards and betted on horses for stakes far beyond what the players could afford, which was very foolish of them; and did this on official premises, which was still more foolish; and during official hours, which was decidedly culpable. But we do hope that these erring young men—for they must have been young—had some better warning of their misconduct than is implied in the public notice we are referring to. "The Postmaster-General deems it his duty to make these punishments known by way of warning, as, in the case of Post Office servants, he regards gambling in any form as a most serious offence," &c.—language which reads like punishing first and warning afterwards. How could these inexperienced subordinates, who studied the sporting rather than the political columns of their daily paper—how could they be supposed to know that Mr. Fawcett's successor had imported a new virtue into the Department?

For the purpose of enforcing his decision, and apparently to justify it, the Postmaster-General reproduces a notice issued nearly seven years ago; and therefore at a period when the loftier virtues were not officially represented as at present. This fact is betrayed in the document itself, which is in the main a matter of fact statement of a real evil then on the increase, and one that it was necessary to discourage. It ends as follows:—"Any servant of the Department who shall hereafter be concerned in betting will render himself liable to dismissal." This is business-like; and the reasons assigned for it are such as would justify any large employer of labour in using similar threats. No doubt it is in the interests of the servants themselves as well as in those of the public that postal and telegraph officers should be forbidden to entangle themselves in betting.

But, granting all this, it does seem to us rather harsh that a whole body of public servants should be implicitly stigmatised as "gamblers" because at one time some telegraphic information got into wrong hands—through the instrumentality of boy messengers if we recollect rightly—or because some sorters or letter carriers at one particular office have cultivated a fancy for card playing and its near relation horse racing. The divulging of telegrams is, we imagine, extremely rare, for we seldom hear of such offences; whilst pilfering from letters is unhappily of frequent occurrence. But in any case such breaches of faith by telegraph servants have nothing to do with betting inside the Department. It is outside betting that holds out this temptation; and outside betting is what the Department does not discourage—rather the contrary, promoting it by affording facilities which practically operate as an encouragement.

Perhaps it was some faint compunction on this score that induced the present Postmaster-General to slip that parenthetical qualification into the minatory paragraph we have quoted above, "as, in the case of Post Office servants, he regards gambling in any form as, &c." The head of a department that derives a large revenue from gambling in its most prevalent form, and increases that line of business to the utmost of its ability, cannot afford to be virtuous indiscriminately. For this very reason we would beg of him that the "exemplary manner" in which he threatens to put down "gambling in any form" may be an example of mercy not

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less than of vigour. From the nature of their occupation, and the one-sided laxity of the Department, a large number of telegraphists are necessarily thrown in close relations with the betting fraternity, and become exceptionally well informed on racing topics. Not that betting messages afford any valuable information for would-be gamblers; that, we should say, is an illusion. But just as Stock Exchange telegraph offices must acquire an exceptional knowledge of the markets, so do offices in racing districts with regard to the Turf. Whether this is a temptation to betting we are not in a position to say; but if it is, the temptation is inherent to the employment, and is rather a misfortune for the *employé* than a disadvantage to the employer. By all means, if public interests demand it, put down "gambling" on the premises—and off them, too, if possible. But let us call things by their right names. It may be expedient and necessary to forbid to postal and telegraph servants what other people may do without reproach; but there is no good in using hard words about it, or assuming virtuous airs which nobody, except with political faith, believes in.

CORRESPONDENCE.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As Mr. Walker's original inquiry for further information about the evidence which transpired at the inquest on the accident at the Healtheries has not been answered, I am glad to be able to give a few details, which may also be of use to Mr. Sennet.

The only fairly correct report was the one which appeared in your columns. I have not got this to refer to, but I recollect most of the points very distinctly.

The only eye-witness described most explicitly that one hand (the left) was on the brush, and that the other "was as though he were feeling round" under the bearing, gradually approaching the lower part of the commutator and the lower brush. The witness understood enough of the question to be struck at the man's action, and watched him with surprise, and doubtless would have spoken in another instant.

The first result was a sudden contraction of the arms and chest, and if there had been hold for the fingers they would probably have closed on some part of the machine. He undoubtedly received the full volts (about 1,200). The left hand broke contact first as he began to fall, and on the tip of the finger of that hand was a slight scar, as though burned by a hot wire.

The interesting part of the evidence was most carefully taken by the coroner, Mr. Braxton Hicks, from the house surgeon, Mr. Bloxham, and I have little doubt that both of these gentlemen, if personally approached, would corroborate my recollections. No shorthand reporter was present, but the coroner took very full notes.

The physiological and pathological evidence was as follows:—First a spasmodic contraction of the arms and chest—in fact of the muscles in the path of the current—described by a gesture by the witness which corresponded exactly to that which is tolerably familiar to those who occasionally receive an accidental shock. The man fell away from the dynamo, collapsed, rolled, and became unconscious—he was probably dead before he fell; a slight mucus foam appeared at the lips. The body speedily became discoloured, rigour never set in, and this, coupled with the fact that the blood never coagulated, is in accordance with several authentic records, but at variance with Dr. Stone's suggestion.

All the blood vessels in the path of the current were highly congested, more so in the chest than in the back. The brain and its membranes were normal, as were all other organs, but the heart was *empty*. The state of the venæ cavæ and pulmonary vein was not described, and it must be assumed that these were not congested. Mr. Bloxham informed me that there was no perceptible evolution of gas or other change in the tissues of the finger tips. It would appear that the mere "shock" is quite enough to account for death; and of the other causes, the complete evacuation of the heart seems to be the most important, this being produced by the general tetanus of the thorax. It appears possible that the well-known process of artificial respiration might be tried with a view of starting the heart's action if the shock had not produced other fatal results.—Yours, &c.,

ALEX. P. TROTTER.

Ball Green Works, Halifax, 19th February, 1885.

ELECTRO-MAGNETS.—MR. BOSANQUET'S LETTER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: This kind treatment is enough to gladden any unit's heart—and you must admit that units have hearts, or else why christen them? I have to thank Mr. Fricker for his letter, and especially I have to thank Mr. Bosanquet. The latter has given me the right sort of information, but, unfortunately, not enough of it. Since reading his letter I have been making experiments, because I have need to know how many ampere turns will saturate or nearly saturate a core of iron 5½in. long by 2¼in. diameter. I find it is in practice, with Bowling iron, between 5,000 and 6,000 ampere turns; according to Mr. Bosanquet's formula I make the figures come somewhere about 9,300. But I made the calculation very roughly. Is this because the magnet approaches the class of short and thick bars for which he doubts the applicability of the formulæ? If so, he would confer favours of great value if he would point out to practical men like myself wherein the modification may most likely lie, so as to give us some data to go upon.

I notice that in u, $\mathfrak{B}$ can vary greatly without much effect. For instance, if the sum of the sine terms becomes ·8, u only becomes 1,900; and consequently $\frac{l}{u}$, as the first term of ρ, does not seem to get that alteration we are accustomed (with short magnets as regards their diameters) to see.—Yours, &c.,

VOLT-AMPERE.

A FAILURE OF THE ELECTRIC LIGHT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should be obliged if you would insert the following letter in your journal. A little while ago you were enabled to chronicle the successful lighting by electricity of the parish church of Brixton, and for a few months the same was everything that could be desired; but now, oh dreadful hour! it has broken entirely down.

The sixty incandescent lamps appear to be arranged six in series, and consequently when one filament goes the other five are in darkness; likewise, as there appears to be no regulator of current, &c. (and I believe the four arcs are driven from the same engine), the remaining incandescents burst out with stronger light till another filament goes, and a series of disasters follow, which end in the parson closing his sermon, and suggesting the singing of a hymn while the gas is arranged.

Is it economy in the matter of leads the company study? Surely sixty amperes could be transmitted direct in a wire a very little larger than they are now using to a distance less than a quarter of a mile. The church paid a good sum for the fittings, and they expect a better return for their outlay than the piping, popping, and smoking exhibition they were treated to last Sunday week, causing a general disturbance, during which many people left the church.

Hundreds of people go home and tell everybody that the electric light is a complete failure. The question is, will other churches take it up while this penny-wise and pound-foolish game goes on? If this kind of lighting is to be more general in churches, the contractors must at least go sensibly to work—that is if they wish to brighten instead of ruin the reputation of this beautiful light.—Yours, &c.,

ONE OF THE CONGREGATION.

Brixton, S.W., February 23, 1885.

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"PAPP" CHLORIDE OF IRON BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the above battery I should like to call attention to the following paragraph which appears in the *earlier*, as well as the later, editions of "Watts's Electro-Metallurgy," § 69, p. 163:—

"A new constant battery has been suggested by Mr. A. Reynolds, in which a solution of per-chloride of iron is used as an exciting fluid, and metallic iron as the positive electrode."

I understand that this cell is claimed as a new invention, but I fail to see how it can be substantiated in the face of the above.—Yours, &c., A. T. B.

Bristol, 25th February.

ERRATUM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: May I be permitted to correct an error which has inadvertently crept into my letter of last week? Instead of "40,000 cubic feet of air raised 8 degrees," I should have written "raised 4 degrees."—Yours, &c.,

A YOUNG ENGINEER.

THE MECHANICS OF ELECTROLYSIS.

BY A. BANDSEPT.

I.

In galvanic batteries, the separation of the constituents of the liquid is due to the differential attraction exerted by the electrodes on the elements of the bodies which are dissociated under the combined effect of this action and that of the re-agent. The elements become separated by a process analogous to diffusion; and the intensity with which the phenomenon manifests itself is in ratio to the transparency of the collector for the electricity evolved during combination, and its opacity for the more ponderable which contained the charges. This selection of the dissociated radicals is due to the form of the polar molecules and to the nature of their movements. Thus, in the ordinary example of the copper-zinc couple, the electromotive force derives its origin from the attraction of the zinc for the sulphuric radical of the acid. This radical, by its tendency to combine with the zinc, brings about the condensation of the molecule H_2SO_4, with elimination of the most subtle element, H, and formation of the new arrangement $ZnSO_4$. But, concurrently with this dissolution of the zinc, there is disengagement of heat, because when two bodies combine—that is to say, when they re-unite in a more perfect grouping the elements of which they are composed, the specific activity of the new system is brought within narrower limits, and a portion of the composing forces appears under the form of external motion; the acid penetrating the substance of the zinc gives rise to the production of hydrogen and heat. The nascent hydrogen absorbs heat in its turn, in order to become gas; so that the disengagement of this element implies the subtraction of an appreciable quantity of energy, both in primary and in secondary batteries, since there is always a molecular separation with electric action.

What has just been said of the various modes of motion, which accompany transformations of bodies in the case of electrolysis, applies equally to every other combination of elements of any order whatever. Energy enters into the constitution of all bodies. They all possess a certain specific quantity of motion, heat, light, and electricity, which determines the conditions of their actual state. If two or more bodies combine with considerable disengagement of heat, this only means that they form a very close union, and that the internal motion of their constituents is transformed, and extends appreciably beyond the narrow space occupied by the newly constituted body. All sudden diminution of the present limitation of a body is *necessarily* accompanied and compensated by an equivalent extension, which constitutes the reaction. This second phase of the double action consists in a particular mode of motion, for which the force *seems* to have the better of the material substratum. In the reciprocal action which takes place in all natural phenomena, one phase distributes itself over a *so much greater number of so much more minute particles*, as the intensity of the action-reaction is greater for a given period of time. Electricity becomes, therefore, a function of the ultimate particles of matter.

To determine the sort of actions which take place in electrolysis, it must not be regarded as causing the transfer of the material elements from one pole to the other. The hypothesis of Grotthus might rather be admitted, that is to say of actions propagating one another nearer and nearer, and consisting of combinations, ruptures and recombinations of molecules, from one to the other electrode. But this hypothesis does not give a complete idea of the manner in which the decomposition takes place; it does not say *why* the motion originates at the contact of the plates and the liquid, nor how the first separation of the elements takes place there, unless the supposition be admitted that this effect is solely due to the differential attraction created on the polar surfaces by the electric current. M. Clausius has, moreover, raised objections to this hypothesis, viz., that the successive decompositions and recompositions would necessitate a too great expenditure of energy, and cannot be simply attributed to the electro-positive and electro-negative properties of the radicals. It is, perhaps, this consideration which has led M. Clausius to his theory of the molecular agitation of bodies, and which has made him suppose that the elements of which the liquid electrolytes are composed often become separated and change partners, so that the current would have nothing more to do than to direct and classify them. This theory, then, constitutes the counterpart of that of Grotthus; and one might ask if it does not err by excess in the contrary direction.

The explanation of the mechanism of electrolysis becomes, perhaps, more satisfactory when the physical conditions of the molecular system under consideration are made to intervene. In that case it is readily understood how the impulse is given to the motion which is transmitted, nearer and nearer, in the liquid column separating the electrodes.

When the circuit is established, the molecule H^2SO^4—in the electrolysis of water—is dissociated; the large quantity of heat incorporated by the radicals, chiefly by the hydrogen, determining the expansion of the molecule. A new arrangement succeeds to the old grouping, in consequence of the direction given to the constituents under the combined effect of the shock of the expanded molecule against one of the electrodes, and of the affinity for the neighbouring body, the other plate. An ideal system of electrolysis is here supposed; and only the relative actions of one of the constituents is brought under consideration.

The conversion of current energy into internal motion of the liquid molecules is specially due to the volumetric properties of the hydrogen. The reducing power of this gas in the nascent state varies with the chemical reaction which has produced it. Now, the combination of the hydrogen with the oxygen disengaging a considerable quantity of heat, and its specific heat for an equal volume being relatively small, it follows that its capacity for *incorporation* is so much greater. The expansion undergone by the thermometrical substance—hydrogen in this case—has the effect of pressing the compound molecule against the surface of the electrode. This molecule becomes deformed in striking the surface; and the reaction exerted by the pressure is transmitted to the core H, which is drawn along in the direction of the current, and which passes by the polar opening, more or less retractile, caused by the flattening of the envelope SO. The molecular deformation which accompanies the separation of the radicals, and which facilitates their penetration into the following elements, is again partly due to the differential gyratory motion imparted to the two components during the transformation of the current into intermolecular energy. In fact, when a body consists of two or more elements differing in density, and which are relatively independent in their respective motions, the element which is the less dense becomes displaced less rapidly than the denser element; and the latter acquires the greater speed. The molecular envelope revolves, therefore, considerably quicker than the core; it becomes flattened towards the ends

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of the axis of rotation, which is turned in the direction of the current; while the core practically retains the oblong form due to the *entrainement* (or drawing along) caused by the passage of the electricity into the interior of the molecule. While the envelope has a tendency to disentangle itself after the manner of a ring, the core affects the form of a hair or cilia, which facilitates its introduction into the neighbouring body. If, at this moment, the action of the current cease, the decomposition will be incomplete; for the tendency of one of the elements to approach the other increases in proportion as they are separated, and until their reciprocal influence be annihilated, in which case polarisation occurs.*

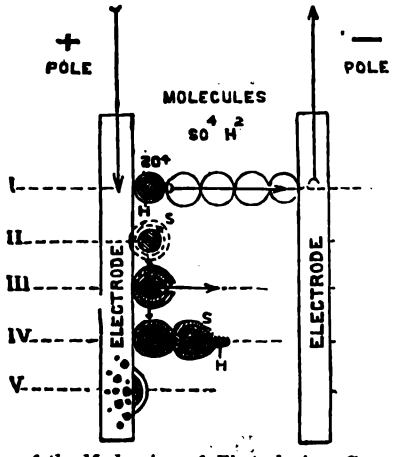


Diagram of the Mechanism of Electrolysis.—General Case.

I. Composite molecule H^2SO^4. II. Expansion by absorption of the energy of the current; shock against the positive and deformation of the molecule. III. Reaction on the core H; differential gyratory motion of the radicals H^2 and SO^4; separation of these elements. IV. Incorporation of H in the succeeding molecule by the polar opening of the covering, skin, or envelope of this molecule. V. Breaking down of the portion SO_4 thus forming the envelope of the first molecule, in consequence of the vacuum produced by the exit of H; elements of this envelope penetrating the polar surface. Disengagement of heat in consequence of this penetration.

This explanation, as will be seen, is only based upon the sole mechanical conditions of the system under consideration, and only examines the most elementary combinations that can be proposed for the formation of bodies, into the composition of which energy always enters. This latter gives them the special volume corresponding with a given temperature. Instead of the dance of molecules or inverted groupings of the preceding theories, without indication of the causes to which these successive transformations are due, it is more natural to evoke the most simple demonstrations, giving for reason the facts observed, and applying to molecular action the laws which govern mechanical phenomena.

After having essayed to explain the mechanism of electrolysis under the most general circumstances and in conformity with the explanation given of it in the diagram, it is advisable to enquire into the nature of molecular action which takes place under the two inverse conditions of polarity.

* A less considerable electromotive force than the minimum contra E.M.F. does not produce electrolysis; but, however slight it may be, it causes a current to traverse the electrolyte.

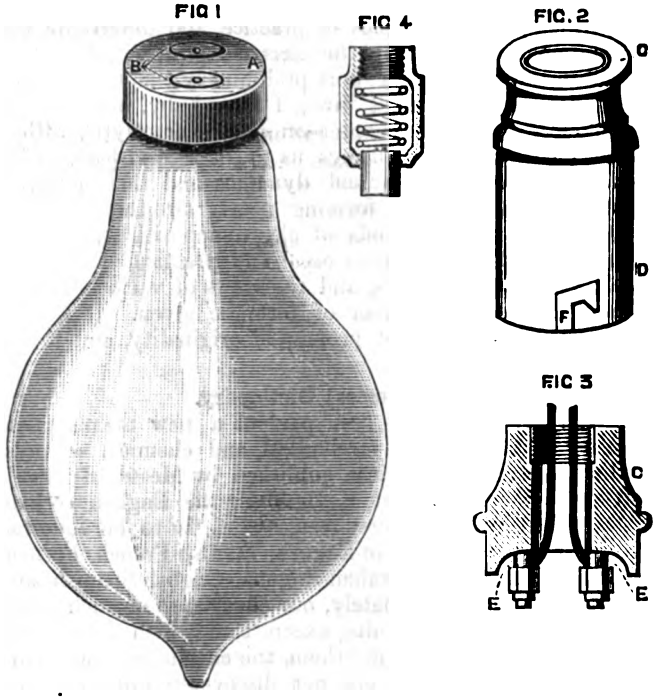
Professor Fleeming Jenkin says in his work, "Electricity and Magnetism," p. 68 (1st edition):—"Feeble currents also traverse electrolytes without producing any sensible amount of electrolysis."

Maxwell admits, in the case of electrolysis, two methods of transfer, one with decomposition and the other by conduction (see "Elementary Treatise on Electricity"). [Maxwell's words will be found on pp. 102—3 and 121 and 122, which we think hardly bear out Mr. Bandsept's views.—Ed. *E.*]

It is, in fact, more natural to suppose that the current should be partially employed in determining the state of dynamic tension which characterises the phenomenon of simple polarisation, and which enables the circuit to establish itself in consequence of the molecular continuity created by the double path of the SO's and the H's arranged as shown in the diagram; that is to say, the H's (cores) constituting the links of a central chain, and the SO's (flattened envelopes with polar apertures through which the contact of the H's is effected) composing the entire envelope, also continuous, of the entire core, from one electrode to the other—A B.

VITRITE LAMP HOLDERS.

Much ingenuity has been exercised in designing incandescent lamp holders, considerable advance having lately been made in electrical and mechanical improvements. Still, up to the present time there has been no great improvement upon the original forms, nor is there much diversity among them. One of the greatest troubles hitherto has been in regard to the platinum loops of the lamps; these being more or less fragile are apt, especially in the hands of the inexperienced or careless, to be strained or broken when the lamps are being attached to or detached from the holder. The "Vitrite" holder is a new invention, both with regard to material and design, and does away with this trouble, there being no strain at all on the platinum connections, while the lamp may be manipulated with great ease and safety by the most inexperienced person. Vitrite is a vitreous material, perfectly hard and incapable of fusion except at very high temperatures. It is also unaffected by damp, sea water, or even acids. In colour it is jet black, and it has a smooth, polished appearance. Its peculiar feature is that, while being a first class insulating material, it admits of the necessary mechanical connections for the conduction of the current being embedded in it in the



process of casting. This very much reduces the cost, and, besides lampholders, renders it suitable for cut-outs, switches, and other electrical appliances. In the accompanying woodcuts, Fig. 1 shows an incandescent lamp with the vitrite cap attached. The cap A, which is secured to the bulb by a specially-prepared cement, has embedded on the top two metal contact pieces, B, pierced with holes, through which pass the platinum wires connected with the carbon filament, and with which these wires make good electrical contact by means of a special amalgam. Fig. 2 gives an illustration of the holder, which consists of two main parts, the vitrite portion C, shown also in Fig 3, and the brass socket-piece D. In the portion C are embedded two split terminals, E, which receive the leading-in wires. Fig. 4 shows the combination nut and piston spring, which, being tightened down upon the wires within the split terminals, complete the circuit when the vitrite cap, in conjunction with the lamp, is pressed in the holder. The brass socket D is attached to C, so that it is easily removable. The slots F in the socket, by which the lamp is held, are adapted to serve, if so required, as a switch, twisting the lamp to right or to left, having the effect of turning it off or on. The holder generally is neat and finished in appearance, and is readily adapted to existing installations.

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NOTICES OF BOOKS.

L'Electricite dans la Maison. Par E. Hospitalier, Paris. [G. Masson, 120, Boulevard Saint-Germain.]

This book is another popular exposition of the applications of electricity to the house. Lighting, telephony, electric-bells, electric clocks, electric cigar lighters, gas lighters, medical electrical apparatus, plating, games, locomotion—all are discussed; and it is shown how electricity is applied in each case. A book of this kind astonishes one, and brings forcibly into view the immense number of applications of electricity, and the increased number of applications of late years. Would it not be possible to introduce books of this sort into our schools, so that an interest might be given to what is frequently a dry task? Perhaps when it is fashionable to have French taught by Englishmen who know French, instead of by Frenchmen who neither know French nor English, common sense may have some power in deciding about school books, instead of pedantry. At any rate, such a book as this of Hospitalier's would form an easy and useful lesson book.

Electrolyse Renseignements pratique sur le nickelage, le cuivrage, la dorure, l'argentine l'affinage des mitaux et le traitement des minerais au moyeu de l'electricite. Par Hippolyte Fontaine. [Paris: Baudry et Cie, 15, Rue des Saints-Pères.]

The work is a very good compilation, intended for practical men, giving specific examples of practice, and describing the modern appliances used in the electro-deposition of metals. We find in the first place a short preliminary chapter on units and fundamental electrical laws, followed by one on the laws of electrolysis. A chapter on work electrolytic, with a number of useful tables, brings us to the second part, which describes various batteries and dynamos and their effective output. The third part, forming nearly two-thirds of the work, treats of various kinds of electro-depositions, such as nickel plating, gilding, and so on. The practice of English, French, and German houses, and the views of various authors are discussed, and a number of formulæ given. It will be seen that the book does not profess to originality, and it will be found good of its kind.

Technological Dictionary.

We have received the first part of a new technological dictionary of the physical, mechanical, and chemical sciences, including electro-technics, just published by Messrs. Symonds and Co., of Bouverie-street, E.C. This, the English-German part, compiled by F. J. Wershoven, D. Sc., is to be followed by seven others, viz., German-English, English-French, French-English, English-Italian, Italian-English, English-Spanish, and Spanish-English. Unfortunately, our experience of such works is that they contain everything except that which happens to be wanted; and, in reviewing them, the excellencies are manifest, while the deficiencies are not discovered until they are brought into practical use. We are, however, disposed to regard favourably this new work, which is calculated to be specially useful to electricians, as we find the words *polarimeter, polarisation, polariscope, to polarise, polariser, polarising angle,* and *polarity.* We also find *resistance, angle of, moment of, overcome, prejudicial, electric, battery,* and *external resistance;* and we hope that, in the next edition, *internal resistance* will also be added, as it is a term frequently in use by electrical engineers.

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

At his fourth lecture, delivered on the 3rd Jan., Professor Tyndall said he was anxious that every one might understand the growth of the subject of electricity. They would remember that he began by simple experiments on rubbed amber—the only knowledge of the subject given to man for 2,000 years. Then Dr. Gilbert broke ground by seeing that other substances besides amber possessed the power of attracting light bodies. So it went on, and ended with the electric machine, the action of which he showed in his last lecture. They would remember that Galvani's first observations were made in the year 1780. He was at a distance from the electric machine, and every time a spark was taken from the conductor the frog was agitated—a fact explained by reference to the return shock previously discovered by Lord Mahon. Six years after this an observation was first made in Galvani's laboratory. He hung his frog with a copper hook upon the iron railing of his laboratory, and finally found, when suspended, that his frog showed, in a very striking fashion, indications of electricity. Here was, in fact, an entirely new source of electricity. Galvani thought he had discovered the principle of light, and so did other men of his time. Volta said: "No, this is the old electricity, only developed from a new source;" and he came to the conclusion that it was developed by the contact of different metals. They must remember the difference between the first experiment of Galvani and the second. The first was explained on the principle that electricity was perfectly well-known; but the second pointed out to them a new source of electricity—voltaic electricity. He would now make an experiment which would illustrate where Volta's knowledge was wanting. A celebrated discussion was carried on between Volta and Galvani, and Volta worked at the subject for ten years, discovering his celebrated pile in 1800. In 1801 he went to Paris, and there showed his pile to General Bonaparte, who at once gave—or rather induced the Academy of Sciences to give—Volta a medal. In 1792 Volta wrote: "This is not anything else but electricity developed by the contact of different metals." And no doubt Volta was right to a certain extent. Placing a piece of copper and zinc together, the lecturer stated that the contact of the two caused positive electricity to flow over the zinc and negative electricity to flow over the copper. The contact of the two undoubtedly produced electricity. That was Volta's source of electricity, and Volta was right in part, but in great part wrong. Galvani, whom he overturned—and who, perhaps, fortunately for himself and his own peace of mind, died two years before the discovery of the pile—had, no doubt, some right on his side. There was such a thing as animal electricity. Volta was a more powerful man and a more powerful experimenter, and for a long time he entirely swept Galvani from the field. Mr. Cotterell had reminded him of a cell which he had there consisting of copper and zinc. He wanted, first of all, to throw a certain doubt on the explanation of Volta as to the contact of different metals by showing them an experiment. [Experiment.] When he dipped this cell into water they would see a glow of the platinum wire. They had the glow produced by simply dipping the cell into the water. Heat was a very powerful thing. Out of heat they could get work of all kinds, but it was impossible that work of all kinds and heat could be got out of contact between two metals. They could not get heat without the using up of some other form of force. They could not get mechanical work out of the mere contact of metals, as that would lead to perpetual motion. He would now show them where Volta's knowledge was at fault. They had before them in front of the lamp a little cell consisting of the combination he had just shown them, only simpler. There was there a little strip of platinum and a little strip of zinc, and they would see that wires were soldered one to the strip of zinc, the other to the strip of platinum. As long as these wires remained out of contact there was no action, as he showed them. Mr. Cotterell would now throw the image on the screen, and they would see what Volta did not see. When he brought the wires into contact they would see what occurred. They saw bubbles passing up the plate of platinum, but there were no bubbles whatever on the other plate. Volta was not aware of the chemical action going on within his cells, but they saw before them a specimen of that chemical action. The current that passed decomposed the water. The hydrogen was liberated on the platinum; the oxygen was liberated on the zinc. The zinc and the oxygen had a strong attraction. A combination of the two was produced and dissolved, and on the one plate they had bubbles, but not on the other. Volta knew nothing about this, not knowing the chemical action going on in his cells. That was the power within the cell which caused the production of heat outside the cell. It was the chemical action that caused the combustion of zinc in the cell; it was the combustion of the zinc in the cell which was the source and maintenance of the current outside the cell. He had there a cell of a substantially similar kind to that which they had already seen. It was devised by Sir William Grove. These forms of so-called voltaic cells were very numerous. They had there zinc and platinum, and as long as they did not bring them into contact there was no action. But the moment he caused contact [experiment] they had that little wire raised to a glow. While this development of heat was going on outside the cell, chemical action was going on in the cell. He might take the zinc and make a fire of it before them, but in the present case the zinc was burned in a liquid, and the difference between that burning and the ordinary burning was this—that in ordinary burning, if they put coal on a fire the heat was developed where the wood and coal were burned. But this form of combustion enabled them to transfer the combustion to a distance. He would now show them a battery of ten cells, and by that means they would get tenfold power, and they would be able to render a larger quantity, or greater length of wire,

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incandescent. Instead of one small piece of wire from one cell they had a considerably larger amount. [Experiment.] The heat which they saw, if it were not developed in the wire, would be developed in the battery. It was transferred from there to the outside, and precisely in the same way they would be able to transfer chemical action. He would cause decomposition to occur outside the battery. [Experiment.] In the former case the cell was complete in itself, consisting of a plate of zinc and a plate of platinum, and they saw that that was capable of producing chemical action. They saw the water decomposed by the passage of the current. On one side they had one gas—hydrogen; on the other another gas—oxygen. Those two when combined were gases which constituted water. He next called their attention to an apparatus which he said was very well known in that institution, devised by Faraday. He also displayed a voltameter, and said it would enable him to show the decomposition of water on a large scale. He wished them to understand this experiment. There was a glass vessel containing acidulated water; there were two plates of platinum, and he would send a current from plate to plate. The passage of that current would tear the oxygen from the hydrogen, and on the one plate they would have oxygen liberated, and on the other they would have hydrogen liberated, and they would see the bubbles. The freed gases were mixed and a current sent into the mixture, when the gases combined with a loud noise. By a second experiment he caused a louder detonation; and by further experiment he obtained the pure gases on the surface of the soap suds. Taking up the bubbles in his hand the detonation was produced in a similar manner. By a further experiment, by means of apparatus which he said was devised by Mr. Cotterell for the purpose, he exhibited the two gases separated, in order to show that they were the two he had mentioned—oxygen and hydrogen. He tested the two by turning on a cock, and in the case of the hydrogen by placing a taper to the cock he produced a jet of light, which burned in the same manner as ordinary gas. The oxygen, on the other hand, he pointed out, would start a smouldering ember into a blaze. He would now pass on from this experiment, showing the heating power of ten cells to a higher heating power—that developed by fifty cells. Producing a platinum wire, he observed that he connected it with the battery of fifty cells. The end of the wire which he held was connected with a battery downstairs, the other end being connected with the platinum wire. [Experiment.] The incandescence followed the wire which he held, and finally it assumed a red heat. Breaking the circuit it went away, as he showed. He would now pass on to another subject, to illustrate a point of very great importance. He wished to show them, in connection with the first experiments, an experiment arranged there. Having called attention to a magnetic needle, and taking two plates—one of copper and one zinc—he explained that it was the mere contact of the two that caused the current of electricity. Instead of a frog, he (the lecturer) had a bit of beef, which he placed on copper, and Volta might have placed, and did place, his frog on copper in this particular way. He had a plate of platinum, which he placed on a plate of copper, and if electricity were developed they would know it by the action of the needle. [Experiment.] They observed the needle moving, and the electricity that now passed through the dead meat was the same as that which had passed to the frog. Volta, therefore, was not right in referring this source of electricity to contact of the metals. This experiment could be varied in many ways. Taking an apple he connected the wire coming from the magnetic needle, and inserting a fork into the apple, and cutting it with a knife, he explained that instead of acidulated water he had apple juice, which produced virtually a voltaic cell. He was now going to draw attention to an extremely important point—to a subject which he had read about a great many years ago, and which he had read about only that day. They had heard a great deal of late about what were called accumulators—that was stores of electricity. He had been looking at a journal and read a letter communicated to it regarding the secondary pile of Ritter. Ritter was a man of genius who was reduced to sufferings of all kinds, and he was sorry to say that he led rather an irregular life. He lived in Germany, and made experiments of an extraordinary kind, which were to all intents and purposes the experiments now made with the electric accumulator. He (the lecturer) had two plates of platinum held by means of a cork. He would first of all make a connection beween these plates of metal and the magnetic needle. There was no action whatever on the magnetic needle. The plates of metal being of the same kind were quite neutral. He would ask Mr. Cotterell to send a current from the battery outside through this cell. He would send a current through the water, which was acidulated water, and oxygen would be liberated on the one side and hydrogen on the other. They would have a film of oxygen on the one plate and on the other a film of hydrogen. Those two films would convert the platinum plates, which would act as if they were of different metals, and would produce effects on the magnetic needle. [Experiment]. He wished to show them the accumulator now used in practical life, and wished the boys before him to remember that it was out of seedlings and germs such as that of Volta that all our great practical applications grew, and they were produced by the discoveries of investigators who aimed at nothing but the love of science and nature. The nation or the community that severed itself from those discoverers, and that merely ran after the practical application of the germs, would soon find itself at the end of its tether. When he spoke thus he simply put in an appeal which was quite necessary. Every one understood that the electric light now seen in the streets was a great thing, but every one would not understand what a small thing it was from which it came. Of course when he spoke of the discoveries of Ritter, if they had not been developed they would not have been of use to humanity. He now wished to refer particularly to a gentleman whose battery he had shown at the institution twenty years ago—Planté. It was he who had made an accumulator on the principle of Ritter, but he used lead instead of platinum. He used lead, and produced a power not previously known. Others came after Planté and improved on his accumulator. He called attention to two cells of Sellon-Faure, and producing a thick platinum wire, he stated that it could not be heated to redness by the fifty cells, the power of which they had seen. [Experiment]. The thick piece of wire was made into a state of incandescence. It was (he said) a great thing to be able to produce such an effect with so small a battery and accumulator. These accumulators were now used for electric lighting, and they rendered the light perfectly steady. He had desired to connect this great result with that previously obtained by Ritter. To pass on to another region of the subject, he called attention to the discovery made in the year 1820 by Œrsted, of Copenhagen, who had been working at it for some time. [Experiment.] The lecturer placed a wire north and south. The magnetic needle was now under the wire, and they would allow an electric current to pass through the wire, and they would observe that the needle was deflected. This was the opening of a new region of discovery in regard to electricity—it was the opening of the region of electro-magnetism. He had an apparatus for reversing the thing he had called a current. He made a connection, and sent a current through the wire, and they would see how the needle was affected. [Experiment.] When he reversed it they would also see how the needle behaved. [Experiment.] He now wished to show them the result of using several coils of wire instead of one wire. He placed the needle between the coils of wire, and they would see that the action would be much more prompt, as the needle would be acted on by all the coils. [Experiment.] Clever men, seeing this action of the needle, said, "Is it not possible to make use of that as a signal—as a telegraph signal?" And from that discovery of Œrsted, Wheatstone and others discovered the needle telegraph. Only on the previous day he was thus enabled to send a couple of telegrams across the Channel by means of this needle. They would understand how it was possible, by arranging these deflections of the needle, to agree on certain signs, and how it was possible to invent a needle telegraph. This discovery of Œrsted was made in 1820, and it caused great commotion. Having next called attention to Arago's discovery, the lecturer stated that soon afterwards it was discovered that by putting a piece of iron within a coil of copper wire, by sending a current round about it, the iron became a perfect magnet. Producing a poker and a plate of nails, he showed that the poker had no action on the nails, but with the aid of a current [Experiment] they saw how the nails were attracted. By breaking the current they would see that the nails dropped. [Experiment.] He next exhibited an electro-magnet. This was a matter worked at by Faraday for twenty years.

PHILADELPHIA EXHIBITION.

(CONTINUED FROM PAGE 316.)

THE CONTINENTAL UNDERGROUND CABLE COMPANY.

("*A. b.*" *of the Section's Classification.*)

This company's plans consist of two distinct systems. The first is described in Figs. 1, 2, 3, 4, and 5,* and the second is described in Figs. 6, 7, 8, and 9. While it is here described more particularly as an electric lighting system, it can as advantageously be applied to wires for other uses of electricity, and is adapted to cross streets, or where one company wishes its own separate conduit, the first-mentioned system being the trunk line system, to accommodate all the different companies in one plant.

In the trunk line system the conduits are constructed with a view of keeping the dampness from penetrating them by either making the walls of asphalte or asphalte blocks (or other anti-moisture material); or by constructing the walls of bricks laid with cement mortar, and covering the outside of the wall with asphalte or cement to keep the moisture out, and then keeping them constantly under pressure of dry air.

* We have not thought it necessary to show Figs. 1, 2, 3, 4, 6, 7, and 8, as all necessary details will be found in Figs. 5 and 9.

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In order to use a comparatively cheap cable, the conduits are kept dry for the protection and preservation of the cables. And further, they are kept under pressure, and objectionable gases are kept excluded, as dampness or gases will not enter against inside pressure.

At first sight it may be said that there will be considerable cost attending the process of pumping dry air into the conduits; but a conduit of one, two, or three miles in length, may be kept under pressure by a very slight power from a single pump, which may be rented anywhere along the line and connection made to the conduits at a very small yearly cost to the company in conformity with the plan in the patent.

Every electric light company has an engine running to compress the air supplied at the generating station for the tubes containing their own wires, as shown in Fig. 6. The principal object in keeping the wires and conduits under dry air pressure is to prevent the escape of electricity from the wires, or reduce the escape to a minimum. While this principle is adapted to telegraph and telephone wires, it is particularly adapted to underground electric light wires, where very heavy currents are passed; for on long circuits the lights on the farthest end of the line or circuit burn dimly and are incapable of giving that brilliancy of illumination for which they are designed, unless the intensity of the electric current is greatly increased over the normal, and this is injurious to the lamps near dynamo electric machines, and requires a greatly-increased expenditure of power used in the generation of the current. By the use of the means employed by this company to retain the full force of the electric current, it is claimed that the distant lamps burn as briliantly as those near the generators, and all burn with a

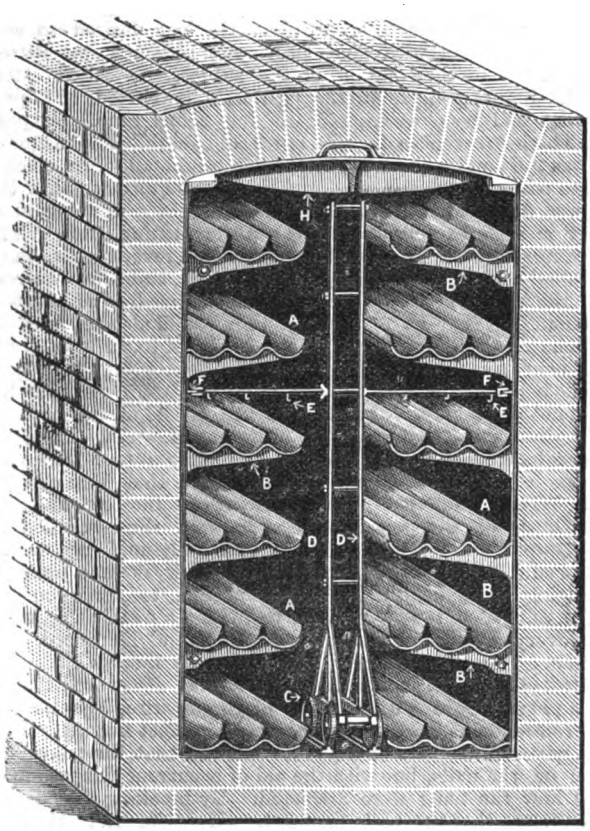

FIG. 5.—Inside measurement, 23 by 27 ins. Capacity, 7,200 wires.

maximum brilliancy without increasing the intensity of the current over the normal, and with a minimum expenditure of power. The accomplishment of this result depends mainly upon two phenomena, viz., the absorption of the moisture from within the conduits, by chemically dried air (the moisture rendering the air a good conductor), and increasing the pressure or density of the air around the conductors and within the conduit, by mechanical means, the same preventing the free escape of electricity from the wires.

The conduit should be made practically air-tight, with an air compressor at one end adapted to constantly force air into said conduit under pressure, and apparatus to contain an absorbent for the extraction of the moisture from said compressed air, and an escape or pressure valve adapted to remain closed until the desired pressure of air is obtained, and attached to the conduit at its other end or at different places along the conduit, and when the air compressor is put in motion to force a constant current of air under pressure into the main and out through said relief valves, and thereby insure a perfect circulation of chemically dry air under pressure.

The greater the pressure or more dense the atmosphere, and the more free the air is from moisture, the less liability is there for the escape of electricity; and, *vice versâ*, to follow a natural law which has been demonstrated, the more rarefied the air around an electric wire and the more moisture it contains, the more freely will electricity escape from the wire. By this process every part of the space within the conduit (not occupied by the wires or their covering) will be occupied by compressed or dense dry air. The insulation should be perfect, as there will be no space so small that the compressed air will not instantly penetrate it. In the case of electric light wires, they will be supported within a tube by glass or porcelain supports, as represented in Figs. 7 and 8, and each wire having an air space surrounding it, the dry compressed air will encircle each wire and insulate it perfectly from all others. A slight insulating covering as an extra precaution should be used on the electric light wires also.

One of the simplest forms, system No. 1, is shown in Fig. 1. A conduit for one or more cables of wires is arranged on either side of the track to accommodate, combined, 800 wires.

That shown in Fig. 1 will probably be sufficient for any one company for many years to come, but where more wires are required the capacity of Fig. 2 should be had, and any single company will probably never require on any street more accommodation for wires than can be had by the conduit shown in Fig. 1; but should a greater capacity be required, the construction shown in Fig. 2 may be used, in which it is seen that pockets are arranged in a manner similar to that shown in Fig. 1, but two deep. In place of arranging pockets as shown in Fig. 2, they may be arranged as shown in Fig. 3, in which the pockets are arranged in single rows, one above the other, four deep.

Figs. 4 and 5 show the system for laying wires on a larger scale, and which is especially adapted to accommodate a number of separate companies. Each of said figures shows the same capacity with but a slight difference in construction, the arms supporting the pockets in Fig. 4 uniting both uprights, and a track is furnished to each apartment of six pockets; while in Fig. 5 the arms or brackets do not thus unite, but leave a vertical passage way from top to bottom of the conduit wherein the motor or carriage, running upon the rail of the bottom, causes its adjustable arms to travel when in the act of laying the cords, wires, or cables in the various pockets upon either side of said passage way. For an entire city only one motor and one carriage will be required, or if the process of laying the wires is to be carried on by either the carriage or motor alone, then the one or the other may be dispensed with; the pockets are made semi-cylindrical, three inches wide at the top and an inch and a half deep, or they may be made nearly cylindrical with a slot on the upper or top side running the whole length to admit

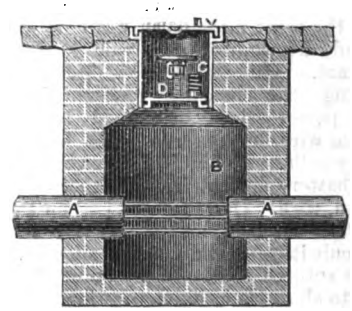

FIG. 9.—Airtight manhole.

of the chain or cord being laid in the pocket by the car with which to draw the cables into position. The space for the motor is between five and six inches wide, but reduced to two inches above the railway, and as it extends from the bottom to the top of the conduit, access to the cables without removing them from their pockets can be had from the top if at any time it should be desired or become necessary.

A vertical space of one to two inches is left between the upper and lower pockets, to enable the passage of the motor or carriage arm and also to enable the cable to be tapped and the wire taken through an outlet.

Service from the conduit to houses may be made by a connection run under the sidewalk and into the cellar, as shown in Fig. 3, conveying wires through said pipe into the houses. The conduit before each house is provided with a plugged branch, which may be opened for connection when required.

Where a number of companies are using the construction shown in Fig. 4, each of said companies can place a suitably arranged lock against admittance to their respective apartments.

Fig. 3 shows an electric motor in the act of drawing a cord or wire cable from a spool supported by an adjustable upright, temporarily placed in a manhole for the purpose, this cable when laid, being adapted to draw the carriage through, which in turn lays a series of cords or cables in the various pockets, as shown in Fig. 2. If it is required that the carriage make two or more trips successively, then the carriage, in being drawn through, may also draw through an additional cable (see Fig. 2), by which said carriage may be returned after laying the first lot of cords or electric cable, and be in readiness for a second supply.

The plan is to place the largest number of wires in the smallest possible space after allowing for space to conveniently get at the wires, lay and relay them, for taking them off to houses and for circulation of dry air, &c.

The walls of the conduit may be built of blocks made from asphalte compound, by an improved process, whereby it becomes impervious to moisture, and possesses great strength; and the metal uprights, brackets, and pockets are connected with the earth to carry off induced electric currents to the earth. By this construction the conduit can be built more cheaply than if constructed entirely of iron, and in addition thereto is not so apt to become electrically charged.

The cylindrical sheet-iron pockets are formed by machinery, and in sections of four to six feet long, the ends of which are turned to receive the supporting brackets, which clamp said pockets from end to end. The uprights and brackets are bolted together in a manner as to clamp firmly the ends of the pockets, thus uniting the adjacent sections, and thereby

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securing a substantially smooth pocket or trough extending from one manhole to the next, the smooth surface overcoming any danger of injuring the cables in the act of drawing them through, and at the same time decreasing the labour. The uprights and pockets with the railway are fitted in the machine shop, and several sections, secured together, are lowered simultaneously to the foundation made for it in the street. These are then closed in, and the conduit is complete.

It is estimated that the system just described can be laid with a capacity of 12 to 15 pockets adapted for different companies to occupy separate pockets for their own wires, each pocket having a capacity of 100 to 200 wires (according to the kind of wires or cables used), for from 8,000 dollars to 10,000 dollars per mile, depending upon the material used in the masonry.

Fig. 6 represents a general view of our electric lighting system, in which we have to deal with currents of electricity of high electromotive force. In such systems in moist weather, or even owing to the dampness of an underground conduit, there is an escape of the current, and this materially reduces its tension so as to render the current incapable of producing a light of more than small candle-power at a short distance from the generating station. This has been one of the obstacles to placing electric lighting wires under ground where the current was to be conveyed over long distances.

By this system the tension of the current is retained at its maximum, and so far as dampness is concerned the tension is unaffected, thereby conveying currents underground over even longer distances than can be done above ground, under the ordinary variations of the hygrometric state of the atmosphere.

To attain this end the air within the conduit is kept under considerable pressure, and perfectly dry. If there is any appreciable amount of moisture in the atmosphere, the air-pump H forces the air first through a dryer, G, which absorbs all the moisture, and the chemically dried air passes into the conduit A, and when the pressure becomes over a fixed amount, the relief valves C allow the excess of air to pass off, thus keeping the pressure in the conduit uniform. Currents of high tension tend to pass off the conductors, but this tendency decreases as the pressure of the surrounding medium (air) increases, and this effect is greatly increased by the thorough drying of the air in damp weather before passage into the conduit. The drying chemicals may be used over and over again, and the system is adapted to any substantially air-tight conduit. As the pressure is constant there must be an efflux, and should there be a small leak the passage of air will be from inside outward, thus preventing ingress of moist air.

Figs. 7 and 8 represent end sections of conduits for electric lighting purposes, in which B are the conductors and A a metal pipe, the conductors B being supported by suitable insulators within said pipe. The conduit A (Fig. 6) may be continuous, with testing doors in the manholes B, or if desired the conduit A may be open on the ends where it enters the manhole, as shown in Fig. 9, in which the door D is made air-tight and covered by an auxiliary cover, F, on the road, the said door D being provided with the relief valve C. In this construction the manhole is filled with compressed air.

This principle may be applied to general conduits, which may also carry the electric light wires, or instead of supplying the whole conduit with compressed air the electric light wires may be enclosed in leaden or iron tubes, and when laid in the conduit, air may be forced under pressure through said pipes.

Comments by the Examiners.

While the system just described is more particularly intended for electric light wires, if applied successfully to currents of high tension it can more easily maintain a good electrical condition for telegraph and telephone wires; and a pipe conduit 3½in. in diameter can be laid for about 3,000dols. per mile, and will contain at least 300 wires.

If absolutely dry air could be maintained in this conduit no doubt it would be attended with many of the advantages claimed for it. But it would be exceedingly difficult to ensure in any conduit of masonry, however carefully built, absolute immunity from moisture, and to keep such a conduit with as many manholes and outlets under air pressure, would, it is thought, be quite impracticable.

The employment of an electric motor to run a cord or chain through the duct for the purpose of feeding in the wires appears to be a refinement which, to say the least of it, lacks simplicity. Further, the expense of maintaining dry air under pressure by a separate apparatus would be an expensive process both in first outlay and subsequent maintenance.

The employment of dry air, however, in wrought-iron pipes has obvious merits as a cheap and manageable insulator, and is well worthy of being developed. The details of the system have not yet been worked out, and the models exhibited showed a new principle, but not so far a practical system.

THE COSMOPOLITAN UNDERGROUND TELEGRAPH, TELEPHONE, AND ELECTRIC LIGHT COMPANY OF NEW JERSEY.

Patented May 8th, 1883.

(*"A. b." of the Section's Classification.*)

This conduit is constructed of highly glazed terra cotta, in sections 2ft. in length, with a tap joint on the top and ends, and is bedded on a cast-iron or terra cotta base plate.

Its interior is fitted with iron frames, placed at suitable distances apart, which clamp large plates of some suitable insulating material, such as glass. If bare wires be used, they may be drawn directly through the holes, but where insulated wires are employed, the opening should be fitted with short sleeves of porcelain or glass, to prevent the insulation being injured.

Some of the sections are fitted with tubular projections for tapping the wires, wherever required, for house-to-house supply.

Cast-iron manholes are placed at suitable intervals.

The slack of the wires is taken up every fifteen feet, and the wires are then clamped.

All the joints are carefully cemented in order to exclude moisture.

It is stated that about one hundred yards of this system has been under trial in Fourth-street, Camden, N. J., and that the cost will not exceed one dollar per foot run.

No provision is made for overcoming the effects of induction in telephone wires. After the duct has been laid and filled with wires, no addition or alteration to the wires can be made without laying open the street down to the level of the base of the conduit and re-making all the joints.

(TO BE CONTINUED.)

THE DRAWBAUGH TELEPHONE CASE.

AMERICAN BELL TELEPHONE COMPANY AGAINST THE PEOPLE'S TELEPHONE COMPANY ET AL.

(CONTINUED FROM PAGE 317.)

As has been remarked, Drawbaugh seems to have discovered nothing accidentally, yet from the beginning to the end of his narrative there is nothing to indicate the conceptive origin or the mental growth of the alleged invention. He presents a number of devices in the chronological order of their production, and testifies that he made one and then another and another, as experiments led him to modifications and improvements. He cannot describe what receiver or other apparatus he used with his first transmitter, and testifies: "I had a number of crude apparatuses, but can't remember exactly the shape of any of them. I had membranes stretched over hoops—over a hoop I remember that; and I had electro-magnets, and the arrangement was varied; I don't remember exactly the arrangement." He testifies that when he used the cup machine he used it in a continuous electric circuit, and thinks he used it as a receiver with Exhibit B as a transmitter. He states that he succeeded in transmitting speech with these two instruments, and, of course, he could only have done this by employing the unbroken undulatory current of electricity. He cannot state how he conceived the initial ideas of the undulatory current and the continuous circuit, or subsequently the theory of any of the remarkable devices which he produces. His answers to questions intended to elicit such information may be illustrated by giving one of them:—"I don't remember how I came to it; I had been experimenting in that direction; I don't remember of getting at it by accident either; I don't remember of any one telling me of it; I don't suppose any one told me." He produces sketches or models or originals of instruments which he says he made from time to time; he states that they were used to talk through on various occasions; and from these outlines of accomplished facts leaves the history of his inventions to be filled out by inference and conjecture. An inventor can hardly forget the process of thought by which a great intellectual conception germinates and matures into the consummate achievement; but Drawbaugh's memory is a blank. If the untutored mechanic educated himself into an accomplished electrician by his own experiments and observations, the incidents and phenomena which revealed new discoveries and illumined the way for new advances would be indelibly impressed upon his mind.

Another group of important facts which are satisfactorily shown by the proofs are those which indicate Drawbaugh's own knowledge that he was not an original inventor of the telephone. Reference has been made to some of the evidence bearing upon his neglect to patent or caveat his invention in discussing the question of his credibility as a witness.

If no honest and reasonable explanation can be given for his conduct, the inference is very strong that he knew he did not have a practical telephone to patent. He may have had a talking machine which was well calculated to excite the curiosity of the community in which he lived; he may have indulged in expectations that in time he could succeed in making a practical speaking telephone, and reap fame and profit from it, but his conduct is almost decisive against the supposition that he had even deluded himself with the belief that he had produced anything sufficiently practical and valuable to patent. He never attempted to exhibit it outside of his own shop to prove that it would transmit speech at a distance of even a quarter of a mile. The proofs show that during all the years from 1867 to 1873 he did not attempt to avail himself of opportunities for demonstrating his invention and bringing it to the notice of friends who were peculiarly qualified to appreciate, and were favourably circumstanced to assist him. One of these persons was Mr. Kiefer, who resided at Harrisburg from 1863 to 1881, and during that period had charge of the telegraphs of the Pennsylvania Railroad Company, and was a member of a firm whose business was the manufacturing of fine electrical machinery. In 1873 he put up a fire alarm system for that city. Drawbaugh made his acquaintance in 1874 or 1875 and brought his magneto fire alarm to Mr. Kiefer for examination. At another time he brought the works of his electric clock. He visited Mr. Kiefer on various occasions, obtained small supplies from him, and habitually conversed with him upon the subject of his electrical contrivances. The period of these visits begins just about the time when according to the theory of the defendants Drawbaugh had constructed Exhibits E and D and the invention was complete. He never mentioned to Mr. Kiefer the fact that he had experimented with a telephone. Mr. Wilson was superintendent of telegraphs for the Northern Central Railway Company at Harrisburg from 1864 to 1875. He was also Mayor of Harrisburg.

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The company had an electrical workshop and supply establishment there for Mr. Wilson's department between 1871 and 1875. During this time Drawbaugh often came to the supply shop and talked with Mr. Wilson about electrical experiments, and obtained parts of batteries, coils, magnets, and other electrical material which the company had cast aside. He brought Mr. Wilson his electric clock and his magneto-electric key, and tried his machine for short line telegraphing at Mr. Wilson's office ; he talked with him frequently about his inventions, but he never mentioned the telephone. His relations with David A. Houck were such that the latter procured him an opportunity to test his magneto key at the telegraph office of the railroad company at Mechanicsburg. Mr. Stees was superintendent of a car company at Harrisburg, having shops in different parts of the city connected by telegraph lines. He was the first person to employ Bell's telephones on these lines when they were introduced into Harrisburg late in 1877 or early in 1878. He was a friend of Drawbaugh, and Drawbaugh would naturally have applied to him if he wanted to test his telephone publicly or practically. Isaac Lloyd was a school teacher and an alderman at Harrisburg ; had known Drawbaugh long ; was accustomed to visit his shop from time to time ; saw many of Drawbaugh's inventions ; was present on one occasion when Drawbaugh experimented with his magneto device for telegraphing at Mr. Wilson's telegraph office. Drawbaugh visited him frequently, and they were accustomed to converse about Drawbaugh's inventions. Drawbaugh showed him his dial telegraph, his electric fire alarm apparatus, and numerous other inventions. Witness assisted him about the electric clock. He was an owner of patents and a friend to whom Drawbaugh applied for loans, and was interested in mechanical subjects generally. The only mention ever made to him by Drawbaugh about a telephone was in 1878, when Drawbaugh told him he was experimenting with a telephone. From 1867 to July 1873 Drawbaugh was intimately connected with the persons composing the Drawbaugh Manufacturing Company, which was engaged in manufacturing devices under Drawbaugh's patents. He was a stockholder and the master mechanic of this company. Among the officers and stockholders were many men of capital and enterprise. There came a time when the managers of the company wanted Drawbaugh to suggest new devices for the company to manufacture. He never suggested the telephone nor attempted to induce the managers of that company to investigate or exhibit his talking machine. A number of the managers and *employés* of this concern testify that they never heard of the existence of the talking machine during the life of the company. Without attempting to refer to other testimony to the same general effect, what has already been referred to shows that if Drawbaugh had seriously desired to bring his talking machine into public notice, and secure the fruits of his invention, he had ample opportunity to do so. Who can doubt that if he had a practical telephone to exhibit, he would have selected just such men as Kiefer, Wilson, and the others to demonstrate it to them and enlist them to demonstrate its utility and value to the public ?

Such an invention was of a kind well calculated to excite public interest, and to impress practical men with a quick appreciation of its commercial importance and its pecuniary value. It was sufficiently perfected, according to the theory of the defence, that a patent could have been obtained prior to 1870 to secure the application of the principle, and to compel every subsequent inventor to pay tribute to the discoverer of a new art. For years it was mechanically perfect, and its efficiency and importance as a great factor in human intercourse could have been demonstrated to the public without appreciable inconvenience or expense. Drawbaugh fully appreciated its importance and value. He had the means to patent it himself, and friends to assist in introducing it into public use. He had the talent to induce others to invest in his inventions. No explanation is possibly why, under such circumstances, his efforts should have left no mark upon the annals of inventive progress, and given no evidence of life beyond the idle curiosity his talking machine excited in the circle of his admirers during all these years. His conduct is more persuasive to show that he did not have a practical, operative telephone than the testimony of a multitude of witnesses who may have seen and heard talking machines at his shop during this period. But the complainant has given evidence of his declarations made by him before he had any interest to pervert the truth which afford a reasonable explanation of his conduct, and go far to explain how the testimony of the corroborative witnesses may be reconciled with the truth.

In 1874-6 Drawbaugh issued a business card advertising himself as "Inventor, designer, and solicitor of patents." On the back of this card is printed a list of his inventions as follows :—Stave heading and shingle cutter, barrel machinery, stave jointing machine ; tram and red-staff for leveling face of mill-stones ; rine and driver for running mill stones ; nail machinery for feeding nail plates ; pumps, rotary and others ; hydraulic ram, the Drawbaugh rotary measuring faucet ; carpet rag looper, electric clock and magneto-electric machine for short line telegraphing and fire alarm and propelling electric clocks. He takes pains to say of this magneto machine on his card that it can be applied to any form of electric movement, and dispenses with a galvanic battery. He had obtained patents for some of these inventions, but he had not for others. He was then experimenting with his electric clock and with his magneto machine for short line telegraphing, fire alarms, &c., and including them in the list of his inventions. The omission to mention the most important one of all of his inventions, one respecting which, according to his present testimony, there had not been a week from the time he made his first cup machines that he had not been engaged with it, one which was complete before his electric clock was complete, is a significant statement by implication that he had no such invention to advertise.

It is to be remembered that when he chronicled his achievements in the autobiographical sketch of 1878, the Bell telephone had been introduced into commercial use at Harrisburg, three miles from Drawbaugh's shop, and the local newspapers had been full of the subject. The cursory allusion in that autobiography to "several kinds of telephones" is in striking contrast with the elaborate description of the electric clock, and wholly inconsistent with the theory that he deemed himself to be the originator of the invention which at that particular time was a topic of universal interest.

In his testimony given in 1879 in the interference proceeding with Hauck, although he did not include the talking machine in the category of his successful inventions, in the course of his testimony he produced a sketch of his faucet, and stated that he made it "about 1874 to 1876 when I was experimenting on telephones or phonographs." He represented himself not as an inventor of that which he is now claimed to have perfected, but as an experimenter with a "telephone or phonograph." It is instructive to read this statement in juxtaposition with a statement made by him to Mr. Matthews in the preceding year. Mr. Matthews was the managing editor of the *Baltimore American*, and in April, 1878, made a visit to Drawbaugh at his shop to see Drawbaugh's magnetic clock, in consequence of information received from a correspondent. He was a careful observer, who went there obviously for the purpose of writing an article for his paper. That his memory is unusually retentive and accurate, and that he is a careful and conscientious man is apparent from a letter written by him in December, 1883, after the proofs in the case had been closed, and in which he manifests a desire to correct certain errors of detail in his deposition. Upon that visit his attention was chiefly directed to the clock ; but he examined Drawbaugh's other inventions, and conversed with him about them, and, among other things, conversed about the telephone. Drawbaugh's statement to him on that occasion was that he had invented apparatus to send messages by means of an alphabet founded upon difference of sounds. He did not profess to be the inventor of the speaking telephone, or assert that he had ever transmitted speech successfully with his apparatus. He said that the idea of transmitting sounds in this manner was not new, and he had read of it some years before in a publication translated from the French, and denied Bell's right to claim the invention of the telephone, because of that publication. In the article founded on that interview which Mr. Matthews subsequently wrote for publication in the *Baltimore American* he adverts to the several useful agricultural and mechanical devices patented by Drawbaugh, and adds : "It may be mentioned that Mr. Drawbaugh constructed a rude telephone long before Mr. Edison loomed up as the 'boss' inventor. He never expected to send articulate sounds over a magnetised wire, but he believed that an alphabet could be arranged after the manner of the musical scale, and that messages could be transmitted and understood by the variations of tone and pitch. This unlettered mechanic came very near anticipating Edison and Bell in the invention of the telephone, and nothing but his poverty prevented him from conducting his experiments to a successful issue."

His advertising card, his testimony before the Patent Office, his autobiography, and his statement to Matthews authenticated in writing were all made when he no had pecuniary interest to colour the facts, and upon occasions when he was anxious to present himself in the most favourable light as an inventor ; and they were all made after his talking machine, according to the theory of the defendants, was a perfected invention, and known to be such by many of his friends and neighbours.

These are declarations, evidenced in writing, and one of them made under oath, which point in but one direction. They are consistent with his conduct. They show that he understood himself to be an experimenter with telephones or phonographs, but not the inventor of the speaking telephones.

The complainant has supplemented this evidence by the testimony of other substantial witnesses who had favourable opportunities to know what Drawbaugh had invented, and who describe what they saw and did not see at his shop, and narrate what he said about his talking machine on various occasions. This testimony indicates that at as late a period as in 1878-79 Drawbaugh was an experimenter, but not the author of the parent invention, nor one who had perfected any valuable improvement upon it, and is in substantial accord with his statement to Mr. Matthews and his testimony in the interference proceedings. What gives point and force to this testimony, and carries the ordinary objections to the reliability of verbal declarations is, that these witnesses are persons who would have been forcibly impressed because of their interest in the particular subject by any assertion by Drawbaugh that he was an inventor of the telephone. During the time in question Drawbaugh had friendly relations with the newspapers of the vicinity ; his friends were frequently communicating laudatory notices of his mechanical and inventive efforts to the press, and he himself visited one of the newspaper offices in the spring of 1878 to show a telephone he had made. The newspapers had published articles about the Bell telephone, but up to the spring of 1878, while many notices had been published in them about his electric clock and other inventions, describing him as a man of extraordinary genius, there had been no mention of the telephone ; and when, in the spring of 1878, the subject was mentioned, he was referred to as one who was "inventing a telephone on a different plan from that now occupying the attention of the scientists," and as about completing the new telephone he is now constructing.

In this connection it is to be noted that, soon after telephones were introduced in Harrisburg late in 1877 or early in 1878, Drawbaugh visited the offices where they were used, examined the inside of the instruments, and borrowed one to take home, which he kept for several days ; and the instrument which he borrowed bears a close resemblance in appearance to Exhibit A, which, it is asserted, he had made in 1873 or 1874.

No extended reference will be made to the testimony of other witnesses such as Mr. Weaver and Mr. Grissinger, showing declarations of Drawbaugh made after the Bell telephone was in commercial use, to the effect that, although he had experimented on the telephone years before Bell, he had obtained no satisfactory results.

(TO BE CONCLUDED.)

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COMPANIES' MEETINGS & REPORTS.

India Rubber, Gutta Percha, and Telegraph Works Company (Limited).

The twenty-first ordinary general meeting of this Company was held at the Cannon-street Hotel, on the 24th inst., under the presidency of Mr. George Henderson.

The SECRETARY (Mr. William J. Tyler) read the motion convening the meeting, and the report of the Directors was taken as read. It has already appeared in *The Electrician*.

The CHAIRMAN: Gentlemen, considering the many complaints one hears on all sides of reduced business and shrinking profits, I think we may be well satisfied with the statement of accounts we are rendering for last year and be thankful for it. The dividend we are recommending is a good one, and if to some of the shareholders it seems that we might do more in that way, they may rest assured that the matter has been well considered by the Board, and that we have good use for the undivided profits we are putting to reserve and carrying forward. In fact, we have felt the need of more capital for some time, and the decision to issue new shares in the terms of the allotment letters now in your hands not only provides more capital, but gives the shareholders a substantial bonus at the same time. More capital, I need hardly remind you, means less borrowing, and therefore less interest to pay, and an important saving by way of discount on all purchases. I need add nothing to the satisfactory statement in the report as to the increased sales of last year. We shall push our business in all directions vigorously, but I hope prudently, both in the old grooves and the new ones opened to us by our Act of Parliament. The fresh capital you are supplying will much facilitate our operations, and I expect will yield you a good return on your investment. We have had several small cable contracts during last year. The Senegal cable was laid towards its close. The 6 per cent. debentures of the Spanish National Submarine Telegraph Company, which we took in part payment for our cables, and which figure in the item of £130,737 in our balance-sheet, seem to us to be a good investment. At a favourable opportunity we intend to issue them. I may explain that the Cape de Verde cable mentioned in the accounts is a short line, between St. Vincent and Santiago, laid under engagements with the Portuguese Government, with the view of connecting those islands and Western Africa—a work which we shall hope to have more to say about on a future occasion. With reference to the premium on the new shares I may mention that we shall add this to the reserve fund. Should the shareholders require any explanation respecting the allotment letters, I shall be glad to give it. I shall now propose:—"That the report and accounts now presented be received and adopted, and that a dividend of £1 per share, tax free, payable on and after the 25th inst., be now declared." When that has been seconded I shall be glad to hear any observations which the shareholders may desire to make.

Mr. S. W. SILVER: I have very great pleasure in seconding the Chairman's motion.

Mr. DIXEY said he noticed that that was the 21st ordinary general meeting of the Company, so that they might regard it as having attained its majority that day. He thought the Directors were entitled to the hearty congratulations of the shareholders, for the Company, under their able management, had reached a position of which they might well be proud, especially as the success of the past promised to be still greater in the future. The Directors had marked this coming of age of the Company by a proposed addition of £104,000 to the capital, and if the Company had justified the shareholders' expectations in the past with a capital of £312,000, yielding as it had this year 15 per cent., he ventured to predict that with a capital of £416,000 it would in all probability exceed their expectations in the future, and give them a dividend of 20 per cent. Larger means implied larger possibilities—the creation of new business, expansion, wider development, and under the present Directors he was sure that that meant increased net profits and increased dividends. They had heard from the remarks of the Chairman that the past year had been one of unparalleled depression, and the Directors of many public companies had had to meet their shareholders almost with a feeling of shame and trepidation. They had had very sorry balance-sheets to present, and no dividend to declare. That was not the case with the Directors of their Company. They met the shareholders that day with a good balance-sheet, and with the intention of declaring a dividend of 15 per cent., and the shareholders also heard words of good cheer for the future. The addition of £104,000 to the capital of the Company had been made altogether irrespective of that meeting consequent on powers conceded to the Directors many years since; but he felt sure it would be satisfactory to the Directors to know that their course of action was thoroughly endorsed by the shareholders, and that while the latter gratefully appreciated the services of the Board in the past, they cherished the greatest confidence in their good management as to the future. He was not going to propose a formal vote of thanks, as that would no doubt devolve on some one else more competent for the duty than himself; but as an old shareholder he was sure that the prosperity of the Company was owing to the management, and he felt that he could not say less in acknowledgment of what had been done for them.

Mr. LAMONT said he would like to ask a question about the increase of capital. No doubt the accounts which the Directors had put before the shareholders were of the most satisfactory character, especially in comparison with those which other companies had been able to submit to their shareholders; but it hardly appeared to him that the Directors were pursuing the most economical course with regard to the raising of fresh capital. An addition of £100,000 to the capital, if they took the dividend at the same rate as the present one, signified a charge of £15,000 a year on the Company in some form or other. They had an amount of £100,000 mortgage debentures, and he could hardly see why they should not proceed further in that direction. He thought that would be a very great saving to the Company. They were going to have, as proposed, £100,000 at an expense of £15,000 a year, but if they were to raise mortgage debentures, even on the same terms as before—and, he presumed, with the improved credit of the Company, those debentures could be raised at 5 per cent. instead of 6 per cent., but assuming that they gave even 6 per cent.—there would be a saving of £6,000 a year. They would tell him probably that they had £50,000 in hand, but that was, so to speak, a gift made to them. But seven or eight years would clear that off, and therefore it appeared to him that it would be a preferable course to raise money by mortgage debentures than by issuing fresh capital. There was, he thought, another consideration with regard to this matter. They might not always find their trade so good as it had been. There might be changes, and they might not always want so large a capital. It might prove a burden at some future time. Increased competition, which they found growing fiercer every day, might lead others to drop some manufactures, or they might not want so much capital as they now thought they required. In that case they would be in a difficulty. They would have the increased capital, and would want to keep up the dividend; or, if they had to return any part of the capital to the shareholders, they would have a difficult task to perform in the return of the money, and they would have to add the word "Reduced" after the title of the Company. Were the Directors thoroughly well satisfied that the course they proposed was the best? It did not appear to be so to him. He thought they would save money by his plan, and that it would be better to have the opportunity of paying off debentures as they fell due; whereas, by the course proposed by the Directors, they would have a weight of capital on their shoulders upon which they might not always be able to pay so good a dividend as they were now proposing.

A SHAREHOLDER asked whether the £130,737 referred to by the Chairman was all in debenture stock or in debenture stock and shares.

Mr. KELSO desired some information with regard to the purposes of the reserve fund. Was it for equalising the dividends? He thought the shareholders would also be glad to receive some assurance as to the limit it was to reach.

Mr. SMALL wished for an explanation of the difference of £50,000 between this year and last in the item of stock-in-trade.

Mr. COCHRANE said he was aware that by the Articles of Association a certain fixed percentage of depreciation was arranged for this Company, but he noticed that they had about £446,000 as representing the property of the Company, whereas the depreciation was only £14,000—apparently only about 3 per cent. That appeared to him to be inadequate.

The CHAIRMAN: In answer to Mr. Lamont's query about the new capital being raised economically, there was a distinct understanding at the time the mortgage bonds were issued that no more of them should be issued while those existing were running. We think that this is the best way of raising the capital we require, and the cheapest way for ourselves. We have had to borrow money, and to pay interest for it, as it is required; but we shall save that, and I think that the new capital will save us a good deal of money. As to the £130,737, the accounts state distinctly that that amount is partly in shares and partly in debentures. It is mostly debentures.

A SHAREHOLDER said it was the market value that he desired to be assured of.

The CHAIRMAN: We think we have kept them well within the market value. We have not put them on the market yet, but we think they are well worth what they stand at in our books. Mr. Kelso has asked the object of our reserve fund. We use it in our general business.

Mr. KELSO asked whether it could be employed for equalising the dividends.

The CHAIRMAN: If we come to require it for the purpose, we think it can be so used. Article 94 of the Articles of Association says: "The Directors may, before recommending any dividend or bonus, set aside out of the profits of the Company, or out of such moneys as aforesaid, such sum as they may think proper as a reserved fund to meet contingencies or for equalising dividend, or for extending, repairing, or maintaining any of the works connected with the business of the Company, or any part thereof; and the Directors may invest the sum so set apart as a reserved fund, subject to the provisions as to the investment of the funds of the Company herein contained." We have hitherto required it entirely for our business.

Mr. KELSO said he had not questioned the authority of the Directors.

The CHAIRMAN: No; we can use it for anything.

Mr. SMALL put a question as to the difference in the stock between 1883 and 1884. It was the Senegal cable principally that caused the difference. As to the depreciation, that is settled by the Articles of Association; but, of course, we have in the £446,000 our steamships. They are standing at a very low value in our books, therefore, and we have not reduced them at all this year. I think I have answered all the questions.

Mr. KELSO did not think the question as to the reserve fund had been sufficiently replied to. How far was it to go on increasing? They had added £20,000 to it this year. If the Directors informed them at what point the reserve fund was going to stop the shareholders could form some view, perhaps, of the position.

The CHAIRMAN: We have not considered that at all yet. The exigencies of the business must guide us to a certain extent.

Mr. KELSO thought a sum ought to be fixed—£300,000, or whatever it might be—and then the shareholders would know what they were doing.

The CHAIRMAN: Well, I am not in a position to answer that question.

Mr. LAMONT agreed that if the Directors were under a pledge not to issue any more mortgage debentures the suggestion he had made would fall to the ground; but he could hardly admit that it was a saving of

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money to raise capital by the issue of shares. They could not be paying more than 5 or 6 per cent. for borrowed money, and the Company, in raising capital by shares, would lose the difference between that rate of interest and 15 per cent., the present rate of dividend.

The CHAIRMAN: We think you will find that we can make good use of that money, and turn it to good profit.

Mr. LAMONT asked whether the Chairman could indicate the various kinds of manufactures they intended going into.

The CHAIRMAN: I would rather not, if you please [laughter]. He then put the motion, which was carried unanimously.

Mr. SILVER then moved the re-election of Mr. Abraham Scott as a Director of the Company, and testified to the value of the services rendered by that gentleman.

The CHAIRMAN seconded the motion.

A SHAREHOLDER: Has he a large stake in the concern?

The CHAIRMAN: 216 shares. He then put the motion, which was carried unanimously.

Mr. SCOTT having acknowledged his re-election,

The Auditor (Mr. J. Weise) was re-appointed.

On the motion of Mr. RAMSAY L'AMY, a cordial vote of thanks was passed to the Chairman and Directors.

The CHAIRMAN: We are very much obliged to you, and will do all we can to give you a good dividend.

The proceedings then terminated.

Telegraph Construction and Maintenance Company (Limited).

Report of the Directors, to be submitted to the members at the 21st ordinary meeting, to be held on Tuesday, the 3rd day of March, at one o'clock precisely.

The Directors have the pleasure to submit their 21st annual report to the members. The accounts for the year show a net profit of £95,096 6s. 10d. after charging the interest on the debentures. To this sum must be added £66,710 1s. 9d. brought forward from last year, making a total of £161,806 8s. 7d. From this amount is deducted the interim dividend of 5 per cent., paid July 22nd, 1884, amounting to £22,410, leaving £139,396 8s. 7d. to be dealt with. Of this sum the Directors propose to distribute a dividend of £1 16s. per share, absorbing £67,230, being at the rate of 15 per cent., and making, with the amount already paid, a total dividend for the year of £2 8s. per share, or 20 per cent., free of income-tax, leaving £72,166 8s. 7d. to be carried forward to the next account. The operations carried out during the year 1884 have been as follows:—A cable, 875 miles in length, which was manufactured in 1883 for the Eastern Extension Telegraph Company to connect Saigon with Tonquin, in the China Sea, was laid in the month of February. The Brazilian Submarine Telegraph Company's duplicate lines between Madeira and St. Vincent, and between the latter island and Pernambuco, part of which were manufactured in 1883, amounting in all to 3,030 miles, were laid between the months of March and July, and three repairs were effected in that company's original cables during the same time. The Direct Spanish Company's duplicate cable between the Lizard and Bilbao, 473 miles in length, was laid during the month of May. A cable forty miles in length has been laid across the Strait of Sunda (between Java and Sumatra) to replace the one destroyed by the volcanic eruption of 1883. Sundry lengths of cable, amounting to about 660 miles, have also been laid in the Australian and China Seas, to make good the existing lines of the Eastern Extension Telegraph Company, the portions thus renewed having been picked up. These services were carried out at various times between the months of February and August. Short lengths of cable have been manufactured during the year for several telegraph companies; the German Union Telegraph Company's cable between Hamburg and Heligoland has been repaired; and in the month of December, the "Sunk" light vessel at the mouth of the Thames was connected by a cable with the postal telegraph office at Walton-on-the-Naze, as an experiment, for the Corporation of the Trinity House. In view of the wear and tear of some of the Company's ships owing to constant work, the Directors decided that the time had arrived to build a new vessel, of about 1,500 tons, builders' measurement. This vessel is being built by Messrs. Laird Brothers, at Birkenhead, and will be fitted with all the improved appliances for laying and repairing cables. The steamship "Seine" is also being supplied by the same firm with new engines and boilers, and is undergoing a thorough refit. With this exception, the Company's ships and the factories at Wharf-road and East Greenwich are in efficient working order. The retiring Directors are Sir George Elliot and Mr. Philip Rawson, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane and Jackson) and Mr. James Glegg (of the firm of Messrs. Quilter, Ball and Co.), who retire, offer themselves for re-election.

South-Eastern (Brush) Electric Light and Power Company.

The following circular has been issued by the Directors, dated 21st February, 1885:—

The Directors have read with surprise and regret the report, dated 9th inst., of the committee appointed at the general meeting on the 22nd December last, and the circular of the 14th inst., addressed to the shareholders by W. Hewett, jun., and R. Braithwaite, as, after the conferences which have taken place, they strongly object to the proposal for the immediate liquidation of the Company. The Directors had an interview with the committee on the 4th inst., at which it was proposed that a joint deputation of members of the Board and of the committee should wait on the Directors of the Anglo-American Brush Corporation, and the Directors' letter of the 5th inst., set out in the report of the committee, refers most distinctly to this arrangement. To the astonishment, however, of the Directors, the committee have issued a report recommending the voluntary liquidation of the Company forthwith, and that afterwards an attempt should be made to effect terms with the Anglo-American Brush Corporation. That is to say, first destroy the value of the property you possess and then try to sell it, as under the licenses from the Anglo-American Brush Corporation the act of going into liquidation cancels the concession. This mode of procedure, being so unbusiness like, is not at all likely to be acceptable to the shareholders. The figures summarised by the Committee most imperfectly represent the approximate balance-sheet prepared by Messrs. Price, Waterhouse, and Co., in order to show the position of the Company on the 31st December last. With regard to the Colchester Installation, which was only completed in June last, and is invaluable as evidence of the success of the B.T.K. System, the Directors have always contemplated either the transfer of the business to the Corporation of the Town, or to a local company to be formed for carrying on and extending it; and in case this could not be accomplished, they would seek to obtain permission from the Board of Trade to cancel the license and remove the plant to a locality where electric lighting would be more appreciated. To sell the plant for the "breaking-up value" would entail a heavy and unnecessary loss. The reference to the Consolidated Company would imply that the sum of £15,000, advanced jointly by this Company and the Provincial Company, "is now wholly represented by patents acquired by that company, and by the plant and fittings of the factory in Cow Cross-street;" whereas the committee were distinctly informed that there was also a large and valuable stock of accumulators, finished and unfinished, and of electrical apparatus of various descriptions. The Directors pledge themselves to use their best endeavours to make terms with the Anglo-American (Brush) Corporation; to try to sell the Colchester Installation as a going concern; or, with the consent of the Board of Trade, to remove the plant elsewhere; and then at an early date to wind up the company voluntarily. The adjourned ordinary meeting to receive the report of the committee will be held here on Friday, the 27th instant, at 12 o'clock noon, and if the Company is to be saved from absolute wreckage the shareholders must reject the recommendation of the committee.

Union Electric Light and Power Company.

A general meeting, called by the liquidators of the above Company, was held on the 23rd inst. at St. Stephens's-chambers, Telegraph-street, E.C. The proceedings, however, were private.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. FEB. 25.		BUSINESS DONE WEEK ENDING FEB. 25. Highest.	Lowest.
Anglo-American	30,	31	31	30
Do. Preferred	53½,	54½	55	54
Do. Deferred	7¼,	7⅜	7⅜	7¼
Brazilian Submarine	11⅛,	11⅜	11⅜	10⅞
Cuba	10⅜,	11¼	10⅞	—
Do. Preference	17,	18	—	—
Direct Spanish	1⅜,	2¼	—	—
Do. Preference	10½,	11½	11⅜	11
Direct United States Cable	9⅜,	9½	9 15-16	9⅝
Eastern Telegraph	11⅜,	12⅛	12⅛	11⅜
Do. 6 per Cent. Preference	13⅜,	14½	14½	13⅞
Do. 5 per Cent. Debentures, 1899	105,	108	105¾	—
Eastern Extension	12⅜,	13⅛	13¼	12⅝
German Union	9½,	10	9⅞	—
Globe Telegraph and Trust	6⅞,	7	7	6 15-16
Do. Preference	12⅜,	12⅞	12⅞	12 11-16
Great Northern	15,	15½	15½	—
Indo-European	32,	33	32	—
Reuter's	7½,	8	—	—
Submarine	195,	200	193½	—
West India and Panama	⅝,	¾	11-16	—
Do. 1st Preference	7⅛,	7⅜	7⅛	7⅜
Western Brazilian	6⅝,	6⅞	—	—
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16,	9-16	9-16	½
Oriental	⅛,	¼	—	—
United Telephone	11,	11½	11½	11 5-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	—	—
Do. (fully paid)	3,	3½	—	—
Hammond Light (£3 15s. paid)	⅜,	½	9-16	½
Swan	⅛,	¼	¼	—
Maxim-Weston	⅛,	¼	—	—

MISCELLANEOUS.

Telegraph Construction	35,	36	36	35
India Rubber, Gutta Percha, and Telegraph Works	22,	23	22½	22

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NOTES.

REPAIR.—The Compagnie Française notify the repair of their main cable to New York.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 27th February amounted to £3,302.

CIVIL SERVICE ESTIMATES.—In the Civil Service Estimates issued on Thursday appears, under the vote for the Houses of Parliament, the sum of £75 for electric installation!

ELECTRICITY IN AMERICA.—It is said that the Electric Locomotive and Railroad Supply Manufacturing Company, of New York, has been incorporated with a capital of £200,000.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of February were £1,457, against £1,588 in the corresponding period of last year.

THE AFGHAN BOUNDARY QUESTION.—The nearest telegraph station to Sir P. Lumsden's position at Akrobat appears to be Meshed, in Persia, two days' camel ride from our Commissioner's position.

THE ELECTRIC LIGHT AND THE NEW TORPEDO BOATS.—We have reason to believe that the contract for lighting the whole of the new torpedo launches by electricity will be given to Messrs. R. E. Crompton and Co., of Chelmsford.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of the above company are as follow:—Receipts for February, £20,400; 1st January to 28th February, £41,000; corresponding months, 1884, £38,680; 1883, £36,440.

ELECTRIC LIGHT AT CANTERBURY.—It is proposed to use the electric light for the illumination of Canterbury Cathedral. If satisfactory arrangements can be made the new system of lighting will be brought into operation in a few months.

THE INVENTIONS EXHIBITION.—The whole of the electric light leads and cables required in the illumination of the above exhibition will be supplied by Messrs. W. T. Glover and Co., of Manchester, who have obtained the contract.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 27th February were £2,682, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February, 1885 (including Government subsidies), amounted to £40,114, and to £38,900 in the corresponding period of 1884, showing an increase of £1,214.

THE ELECTRIC LIGHT IN ALGIERS.—We are indebted to our contemporary *Electricité* for the information that the electric light is about to make its appearance in Algiers. The Edison Company have, it appears, made an offer to the municipality of that town, and a commission has been appointed to report upon the project.

THE ELECTRIC LIGHT AT GREENOCK.—At a meeting of the Greenock Town Council, it was intimated that a trial of the electric light had been made at Prospecthill the previous day which was considered very satisfactory, and they hoped within a week to be able to invite the Police Board to witness a trial of the whole system.

CUBA SUBMARINE COMPANY.—The number of messages passing over the lines of this company during the month of February was 3,225, estimated to produce £2,700, against 3,482 messages, producing £3,099, in the corresponding month of last year. The traffic receipts for the month of November, estimated at £2,475, realised £2,326.

PHŒNIX FIRE OFFICE RULES.—We have received the sixth edition of the Phœnix Fire Office rules. These are intended to indicate the conditions under which electric lighting may be safely carried out, and contain many useful hints upon the fastening and insulating of conductors, as well as some equally useful facts for the guidance of workmen and others having charge of installations.

THE SOCIETY OF TELEGRAPH ENGINEERS AND ELECTRICIANS.—A meeting of this society will be held at the Institution of Civil Engineers, 25, Great George-street, Westminster, on Thursday, 12th March. Papers will be read "On Constant Electromotive Force in an Electric Light Circuit," by Sir David Salomons, Bart., member; and "On Electrical Definitions, Nomenclature, and Notation," by Andrew Jamieson, F.R.S.E., member.

THE SUPPLY OF COPPER.—The quantity of copper imported by England from America has greatly increased during the past three years. In 1882 the quantity was only 745 tons, which rose in 1883 to 9,410 tons, and last year to as much as 17,309 tons. This is the more remarkable as, so recently as 1880, America has had to import from Chili to meet its home demand. Australia is said to have produced about 10,800 tons in 1884, 9,700 in 1883, and 9,800 in 1882.

TELEGRAPH SHIPS AS TRANSPORTS.—The Government have decided to place three other vessels at Suakin, besides the "Calabria," for condensing purposes. They have chartered the Telegraph Construction and Maintenance Company's ss. "Kangaroo," and the ss. "International," belonging to the India Rubber, Gutta Percha, and Telegraph Works, Silvertown. It seems that telegraph ships are preferred on account of their tanks, which are utilised to carry fresh water.

APPOINTMENT.—We have much pleasure in announcing the appointment of Mr. W. H. Massey to the post of mechanical and electric light engineer to the Queen. It will be remembered that Mr. Massey personally supervised and successfully carried out the electric lighting experiments at Windsor Castle and at Buckingham Palace during the past year. The importance of this appointment, as an official recognition of the desirability of establishing such an office, is undeniably great.

MONUMENT TO THE LATE SIR W. SIEMENS.—The monument to the memory of the late Sir William Siemens, F.R.S., has recently been placed over his grave in Kensal Green Cemetery. It consists of a cross of red Aberdeen granite, in which is inserted a medallion of the deceased gentleman in Greek marble. The work has been executed by Mr. A. Bruce Joy, of West Kensington, and has given great satisfaction to Lady Siemens, and to others who have had an opportunity of inspecting it.

LANCASHIRE AND CHESHIRE TELEPHONE COMPANY.—We have just received the February list of subscribers of the above-named company. From it we learn that no less than 3,500 firms in Lancashire and Cheshire have availed themselves of the facilities afforded by telephonic communication; while the number of exchanges already established or in course of formation is about thirty. The company have also call offices in Manchester, Liverpool, Blackburn, Preston, and other towns.

NEWS!—We have to thank our contemporary, *Industria & Invencions*, for the following:—The French Government,

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already in communication with Senegambia and Tonkin, have contracted for a cable from Zanzibar to Mayotte (one of the Comoro group), Nossi Bé, St. Mary, and Tamatave, which will be ultimately extended to the islands of Réunion and Mauritius. France will thus, says our contemporary, be "in telegraphic communication with *all* her possessions in different parts of the world."

LONG-DISTANCE TELEPHONY.—A trial in the direction of telephoning long distances was made on 5th February, at the Postal Telegraph Company's building, New York, by the Long-distance Telephone Company, working Webster Gillett's patent. Connection was made with Meadville, Pa., a distance of 509 miles, with a satisfactory result. Next, Chicago, over a thousand miles by wire measurement, was connected, and worked well at first, but later something got out of order, and the results were not so satisfactory.

EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of February, 1885, amounted to £61,784, and to £57,396 in the corresponding period of 1884; increase, £4,388. In publishing these exceptionally large receipts, due mainly to the military operations in Egypt and China, it should be stated that the expenditure will also show a very considerable increase, several important cables having been interrupted during the past month, necessitating the constant employment of all the company's repairing ships. As the cables are duplicated, and in some cases triplicated, the company's revenue has suffered very slightly by the interruptions.

THE ELECTRIC LIGHT IN MYSORE.—The Government of Mysore have granted to the Consolidated Electric Company, manufacturers of the B. T. K. Storage System, the sole right for 55 years of lighting by electricity in the Province of Mysore. The concession permits the company to acquire lands for the necessary works, and to put down plant under or over any public roads or thoroughfares. The Government admits all plant and materials required for the business of the company free of taxes or duties of any description. The principal towns in the province are Bangalore, Mysore, Chitteldroog, Bednore, Seringapatam, and Shemocca. The electric light has been introduced on a very small scale in Mysore.

TELEGRAPHISTS FOR THE SOUDAN.—Fifteen additional volunteers were demanded on Monday last from the Reserves belonging to the Field Telegraph Corps of Rifle Volunteers, and the number was speedily made up. It will be remembered that twelve of this body are now serving in the Soudan, or rather in Upper Egypt, their most advanced station at present being Wady Halfa, the nominal boundary of Egypt proper. This Reserve Telegraph Corps consists of only fifty men, so that more than half of its strength is now on active service. Fresh demands are also being made on the Ærial Telegraph Corps of the Royal Engineers, whose numbers we should imagine are now greatly reduced. The fifteen volunteers are under orders for the Eastern Soudan, and will pr obably sail next week.

LIGHTING OF THE SCHAERBEEK STATION.—It is said that the Belgian Government have decided to light the Schaerbeek Station, which is one of the most important, by electricity. The companies tendering are:—La Société Zurichoise des Téléphones de Zurich; La Compagnie Belge et Hollandaise d'Electricité de Bruxelles; La Compagnie Générale d'Electricité de Bruxelles; and La Compagnie Industrielle d'Electricité de Bruxelles. The engineers of the Administration of the State Railways have been instructed to have the necessary works carried out. They have under consideration the following items:—(1) The system of arc lamps and regulators; (2) the price per lamp-hour; (3) the number of lights; (4) the total expense per hour; (5) the sum total of the estimate. The tenders range from £4,400 to £1,150; the latter, that of the Compagnie Générale d'Electricité has been accepted, and the work is being pushed forward with vigour. The Gülcher lamps and dynamos will be employed.

POLITICAL ECONOMY.—It has been said that the difference between social and political economy is that in the first case a penny is spent to save a pound, and, in the second, a pound to save a penny. The Admiralty refused to grant the very small sum required for the lighting of the "Dreadnought" by electricity before she left England, and, as a necessary consequence, her unfortunate officers and crew are left to grope about as best they can. Oil lamps are not only dangerous and expensive, but ill-smelling and inadequate to the purpose of efficiently lighting a large vessel, while electricity affords a light which is invaluable for service in a man-of-war; is cheap, cool, and inodorous. However, if it is not thought desirable to properly equip one of our finest vessels, such as the "Dreadnought," the Admiralty authorities have, at all events, determined that the "Devastation" shall be so lighted, and as that vessel is about to be laid up in dock, in order to undergo extensive repairs, for an indefinite period, it is no doubt the same thing. Such, at any rate, is the opinion of *Truth*.

THE ELECTRIC LIGHT IN THE NEW HOUSES OF PARLIAMENT AT CAPETOWN.—An interesting experiment was made lately with the lighting of a portion of the new Houses of Parliament by the electric light. The shed and engine which did service in the Good Hope Gardens for the old House of Assembly have been removed to the piece of ground in rear of the Public Library and Museum, and excepting that a more powerful machine has been provided it is only intended at present to utilise the existing appliances. Under these circumstances only the new Assembly Chamber and a few of the offices, such as that of Clerk of the House, and the Speaker's room, will be lit up in this manner. The new machine is one of Edison's "L" dynamos for 150 sixteen candle lamps. There are 108 of these incandescent lamps in the Assembly Chamber, the others being distributed amongst several of the offices. The experiment was decidedly successful, the light being beautifully soft and clear. The electrician now in charge is Mr. Hortsek, from Edison's Company, and he is to be congratulated upon the smoothness with which the experiment passed off. The greatest satisfaction was expressed with the electric light and the appearance of the building under its influence.

ELECTRIC LIGHT IN DWELLINGS.—The portable self-contained electric lamps for use in private dwelling houses made by Messrs. Blumberg and Co., of Cannon-street, are worthy of commendation. These lamps are dependent upon no dynamo engine or working machinery of any kind for the generation of the electric fluid. The current is produced by a small primary battery (Skrivanow), which can be concealed inside a china lamp of ordinary size and pattern. The battery consists of a little oblong box, divided into cells in which there are zinc plates and a packet of chloride of silver, the excitant being a solution of caustic potash. The actual illuminant is one of the little Swan lamps of low candle-power. It will be seen, therefore, that the lamp can be moved about precisely in the same way as if it contained paraffin or colza oil, while it can be introduced into any dwelling house without the necessity for the installation of machinery of any kind. The primary cost varies from 15s. to 50s., according to the size of the battery. According to a rough estimate, it is stated that a light of 25 candle-power will last without being attended to for a space of

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twelve hours at a cost of about eightpence. The Skrivanow battery is described in another note.

FOURNIER'S DROMOSCOPE.—The problem of the action of the mariner's compass is singularly complicated by the varying magnetism of the vessel, which causes a deviation of the compass needle. If we let Z = the *cape*—that is to say, the angle formed by the needle of the compass to the axis of the vessel—the deviation of the compass will be seen to result from three distinct deviations—the first, a, constant and independent of the cape; the second variable with the cape z, and is the function of the magnetism of the vessel, the horizontal intensity and inclination—called the *semi-circular* deviation; the third independent of the magnetism of the vessel, and of the globe, and is the function of the geometrical co-ordinates of the pieces of soft iron in the vessel—called the *quadrantal* deviation. The formula generally giving the *true* cape Z in terms of the *false* cape z is then :—$Z = z + D + a + \beta \sin z + \gamma \cos z + \delta \sin 2z + \epsilon \cos 2z$. D being the declination, or the angle formed by the magnetic meridian with the true meridian of the globe; a, a coefficient introduced by the first deviation; β and γ, the relative coefficients of the semi-circular deviation; and δ and ϵ the coefficients of the quadrantal deviation. The instrument called the dromoscope not only registers the various deviations we have described, at the will of the observer, but supplies the correction. The apparatus consists of two needles, pivoted on the same axis; one of them, called the director, shows the false cape z, while the other indicates on a second circle, excentric to the first, the true cape Z. The instrument is, in fact, a contrivance for calculating the deviations of the compass, giving the correction at a mere reading.

THE UNIT OF "R."—Sir. Wm. Thomson expresses his opinion that, at the next congress, 0·2 will be added to the 106 c.m. adopted by the late congress. The following effusion is to be warbled to the air of "The Vicar of Bray." We should have thought that "Ohm, sweet Ohm" would have been more appropriate; but then, you see, we are not poetical :—

In early days I, for a while,
Did soar to truth no higher
Than "equal to a statute mile
Of special copper wire."
But I'm correct, as I'll maintain;
I've always been so far, Sir!
For whatsoever Congress reign
I'll be the Unit of "R," Sir!

When Siemens came it seemed to me
Advisable to swear, Sir,
I was a "METER OF 'Hg,"
One millimetre square, Sir!
But I'm correct, &c.

Then when they crowned great C.-G.-S.,
Lest I should look a dunce, Sir!
I clearly could do nothing less
Than "B A ohm" at once, Sir.
So I'm correct, &c.

Now Paris alters once more still;
So, without hesitation,
I am a "Legal Unit"—*till*
The *next* determination.
So I'm correct, as I'll maintain,
Till Thomson says, "Na! na!" Sir!
Then add "point two," and so again
I'll be the Unit of "R," Sir!

C. W. C.

ELECTRIC CONDUCTIVITY OF SOLUTION OF CARBONIC ANHYDRIDE.—The experiments of Hittorf on the migration of the ions during electrolysis point to the importance of electric functions in deciding the chemical constitution of solutions of gases in water. Kohlrausch has also proved by experiments on the electric conductivity of solutions of ammonia that these do not contain the hypothetical combination—ammonium hydrate. The following are the principal results of experiments on solutions of carbonic anhydride under increased pressures, varying from 1 to 25 atmospheres. (1) A solution of carbonic anhydride in water forms one of the worst conductors known, the conductivity, under normal conditions, being about $\frac{1}{20}$th of that of spring water. (2) Although it is commonly assumed that a solution of carbonic anhydride in water contains the hypothetical carbonic acid, H_2CO_3, in that it possesses an acid reaction, yet, according to Kohlrausch's experiments, the conductivity of such a combination should be equal to $202{,}000 = 10^{-10}$ C.-G.-S. units, or more than a thousand times greater than the highest value found. (3) Change of pressure produces no alteration in the conductivity, which would appear to show that the carbonic anhydride is liquefied in the process of solution. (4) Carbonic anhydride is soluble in water at the temperatures above its critical point. If, then, the solution were a mixture of water and liquid carbonic anhydride, it is probable that irregularities in its conductivity would be observed at the critical point; but this is not the case. (5) The curve of the conductivity as a function of the temperature is analogous to the curves described by Kohlrausch for oxalic, tartaric, and ascetic acids, in that it ascends rapidly for increase of dilution. This would seem to point to an analogy of constitution of a solution of carbonic anhydride in water with these acids.

TELEGRAPH POSTS.—According to the *Daily News*, the nine hundred miles of additional telegraph lines required outside of London for the cheaper service in August have robbed the Norwegian pine forests of some 20,000 trees. English larches used to be employed for telegraph posts, but they proved to be sadly wanting in durability. The wood was of too close a grain to permit of its being impregnated with creosote, but yet incapable of resisting the effect of moisture for any great length of time. Larch, therefore, has been discarded, and all our telegraph poles are now imported from Norway. In America they appear to have given the closest attention to this subject, for it has been found that dividends are very largely dependent on the durability of poles. They use various kinds of wood, cedar by preference, and it is said that the durability of a pole depends to some extent on the time of year in which it is cut down. A sound cedar post felled in winter, when the sap is low, will last for sixteen years. A spruce pole will last seven years only under the best of circumstances. The soil in which they grow is said also to have considerable influence on the lasting powers of telegraph poles, and no doubt also much depends on the soil and situation in which they are planted for service. In America it has been found that the whole of their lines want completely renewing every ten or fifteen years at the utmost. The importance of the supports of a telegraph line becomes particularly obvious when it is remembered that the breaking of a post involves not merely the necessity of renewing it, but also broken wires and interrupted service by throwing the various wires one across the other. It seems probable that by and by Norwegian pines in this country will give place to iron posts, which, of course, may be made somewhat more ornamental than bare pine poles, and possibly would prove sufficiently durable to more than counterbalance the extra cost. This is a point, however, which at present seems to be doubtful. An iron post will cost four times as much as a

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wooden one, and how many times longer it will last there is at present no sufficient evidence to show. A four-fold initial outlay is a matter that is not to be altogether overlooked.

A NEW INDUCTION TELEGRAPH.—An ingenious apparatus has been designed by Mr. Phelps, of New York, by means of which communication may be established with a train whilst the latter is in motion. The contrivance is based upon the phenomenon of induction between two parallel wires. A copper conducting wire is arranged in the centre of the railway track; another wire runs along the bottom of the railway car, with which wire he connects a telegraph sounder located within the car. Whenever an electrical signal is sent through the track telegraph wire, it produces by induction a corresponding current in the wire attached to the car, and this current works the sounder, thus delivering the message; or a message may, in the same manner, be transmitted from the car to the railway station. The track wire, whence the induced current originates, is placed by Mr. Phelps in a wooden casing at a point equi-distant from the rails over which the cars pass. This casing does not rest directly upon the sleepers, but on blocks of wood, four inches long, two inches wide, and thicker or thinner according as the sleepers are higher or lower in the centre. Four men, it is said, will fit and lay two miles of these in a day's work, and with such nicety that the top of the box containing the conductor will be a trifle below the same plane as that in which the top of the rails lie. At points where branch or other roads cross the main line, the conducting wire passes, in an india rubber tube, under the interfering rail. The electrical arrangements on the car are as follow:—Running the entire length of the car between the forward and rear cars is the induction coil. There is a two-inch iron pipe, which is suspended so as to hang seven inches above the track conductor that rests upon the sleepers. Within this suspended iron pipe is a 1¼ india rubber hose, which in turn contains ninety convolutions of copper wire, insulated with paraffin. This copper wire extends round and round through the suspended iron pipe and up along the upper part of the car, and forms a circuit a mile and a half in length. The pulsations which pass over the track wire when taken up by the induction coil are received by an ingeniously-made polarised relay, the action of which is in no way disturbed by the motion and jarring of the train. From this instrument the received impulses are conveyed to an ordinary telegraph sounder, worked by a local battery. A company has been formed to exploit this useful invention.

THE THERMOMICROPHONE. — The new microtelephonic system of Dr. Ochorowicz, to which allusion has already been made in our columns, is composed of two instruments which, in a paper read during the past month before the Société Internationale des Electriciens, were thus described. The magnetic receiver differs from all other apparatus of its kind: (1) By the employ of two vibrating plates equally polarised by the same magnet, and embracing the two extremities of the coils; (2) by the mode of attachment of the telephone case which, instead of being immobile, also vibrates, and is fixed only by means of the second vibrating plate. An examination in detail demonstrates the perfect utilisation of the magnetic field and the absolute concordance of the vibrations of every part of the system. The thermomicrophone is, it is averred, the most powerful of all the telephonic transmitters. It reproduces sound in a loud tone even when the speaker is to some degree distant from the instrument, while music and song can be so transmitted as to be heard by a large assemblage of people. The microphones with which we are acquainted may be classified as follows:—(1) The Edison, which embraces all the transmitters acting by *pressure;* (2) and the Hughes, comprising all those which act by means of vibrations, and which have always a certain number of carbons, variously disposed. The thermomicrophone occupies an intermediate place, being acted upon partly by vibrations and partly by pressure. The principal feature of the system, however, is the introduction of heat. Generally speaking, all microphones are more or less heated during action, and the thermal effect increases their sensibility; but there is one great disadvantage attending it—the heat renders the apparatus irregular. The difficulty has been to regulate the instrument so as to allow for the generation of heat and guard against its disturbing influence. The action of the microphone is, as has been said, irregular; its resistance is then almost nothing, but from the moment that a current of 18 to 20 milliamperes passes through it, it becomes heated, its resistance is augmented (to about a mean of 200 ohms), and the apparatus will be found regulated for transmission. Under these circumstances it is evident that the exterior temperature will assist or impede the effective working of the transmitter; but by the application of a layer of insulating material in the interior of the microphone itself, Dr. Ochorowicz has been able to maintain a temperature of from 13° to 39°, which is sufficient for all practical purposes. At the conclusion of the paper the thermomicrophone, actuated by five Leclanché cells, was placed in a room on the third floor of the building, and the receiver upon a table in the conference room some 50 metres distant. The result seems to have given great satisfaction, the articulation of the instrument being so distinct that the three hundred members of the society were enabled to hear it with perfect ease.

ARCHITECTURAL EXHIBITION.—An architectural and building exhibition, organised by the new Society of Architects, has been held during the past week at the Floral Hall, Covent Garden. The chief novelty in electrical appliances seems to be a portable invalid's call, consisting of a case containing a Leclanché battery, a bell, a push, and several yards of double insulated wire. It is intended to place the apparatus temporarily where the bell is required to ring, and lead the push to the bed of the invalid. The arrangement exhibited by Julius Sax is distinguished by careful construction. One of those shown by Eck, Callow, and Co. was lately supplied to H.R.H. the Duchess of Albany, and has the push sunk in a convenient form of oblate spheroid ball, so that it is not likely to be actuated unintentionally. The variety shown by W. Pressland is distinguished by great cheapness; and he has devised a pear-shaped ball with duplex action, with the ordinary push at the bottom, and also capable of being actuated by pulling down like an ordinary bell-pull. Julius Sax also shows a tell-tale clock for checking the rounds of watchmen. The clockwork turns a drum covered with paper, divided into hours, &c., and also into spaces corresponding with various parts of the building to which wires are led, terminating in pushes. The watchman has to touch these pushes in succession, thus marking a dot upon the corresponding space, and producing a permanent record of his rounds. There is an electric water gauge for registering, inch by inch, at the pumping station, the rise and fall of water in a tank or reservoir, and ringing a bell when the water reaches the highest or lowest point. An electric billiard marker has pushes in all the sides of the table, for use in private houses. Eck, Callow, and Co. show Brown's automatic fire alarm, in which, on the melting at 160deg. F. of a fusible band, a bell rings, a visible signal is shown, and, if it be wished, a Bengal light is ignited. Milton Syers exhibits, for

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the first time, a syphon cistern and water-waste preventer, in which the valve for allowing the confined air to escape, and the water to flow, is opened by a magnet drawing down its armature on contact being made. Paul Pfleiderer had on view his "Universal" kneading and mixing machine, which is used, among other purposes, for the paste for which electric light carbons are made. The exhibition was lighted—we were going to say—by the Maxim-Weston Electric Company, but, unfortunately, the electric light was found wanting when most required. The President's *conversazione* was held in semi-darkness; and it was not until eight o'clock on Tuesday that unfortunate exhibitors, not provided with other means of illumination, could show off their wares to advantage. We heard vaguely of a fly-wheel breaking and of a piston giving out; but, if so, why was not the engine duplicated, so as to provide for emergencies? We were at considerable pains to ascertain the real cause of failure, but were invariably met with the inertia of resistance, to say the least. There are six Maxim-Weston arc lights in the Floral Hall, and one outside; and there may be more that we do not know of. There are also two rows of ten Maxim incandescent lamps in the temporary theatre; and we believe there are a few in the engine room, into whose sacred precincts we were not permitted to set foot. And these lights are—or should be—maintained by two arc and one incandescent dynamos. We wish the Society of Architects better luck next year in their lighting arrangements.

Influence of Electricity upon a Liquid Film.—A further account of the experiments of Professors Reinold, F.R.S., and Rücker, F.R.S., as to the influence of an electric current in modifying the rate of thinning of a liquid film, have recently been published in the *Philosophical Magazine*. One of the primary objects of this investigation, of which a description was published in *Proceedings* of the Royal Society in 1877, was the determination of the electrical resistance of films. A Wheatstone bridge was employed for this purpose, and a current was passed through the film only at a moment when observation was required. It was then seen that the films became black, and measures of their resistance while displaying this colour were successfully obtained. Afterwards continuous currents were employed, and the difference of potential between two fine wires thrust into the film was measured by an electrometer, and compared with the resistance between two other points in the same circuit, separated by a known resistance. The results obtained were not altogether of a satisfactory nature; but the later experiments are interesting as showing the behaviour of the films, and the nature of the colours evolved under the influence of the electric current. The liquid employed consisted either of a solution of potash, soap in water, or of *liquide glycérique*, containing a certain portion of nitre to increase its conductivity. The films had the form of vertical cylinders; the upper and lower ring supports being of platinum, and about 33 millimetres in diameter. The cylinders were, as a rule, from 30 to 40 millimetres in length, but occasionally other lengths were under examination. Three films were observed simultaneously, two of them being in one glass box, and the third in a separate glass box. The two that were together were supported by platinum rings identically alike, and sharply beveled at the edge; the edges of the supports of the third were much thicker, and were rounded. It could thus be ascertained whether any difference in the behaviour of the films was due to the form or thickness of their supports. No such difference was observed. Each of the film boxes was placed in the centre of a water tank with glass sides, in order to prevent rapid changes of temperature. In all cases the films were surrounded with air saturated with the vapour of the liquid of which they were made. The constancy of the hygrometic state of the air, and that of its temperature were indicated respectively by a hair-hygrometer, and a thermometer inside the glass case. The films were blown with air, which was first dried and then passed over some of the soap solution in a wide tube. The state of the air inside the film was thus approximately the same as that on the outside. The current employed was generated by a Siemens dynamo, and passed through a sensitive reflecting galvanometer, the deflection on the scale measuring approximately the strength of the current. This varied from about 100 micro-amperes to 0·5 of a micro-ampere. Under these conditions it was seen that in less than a minute after the adjustment of the film (potash-soap solution, without glycerine, 40 millimetres) to the cylindrical form, narrow rings of colour appeared, and white of the first order of Newton's rings was soon seen at the top, generally bordered by a deep band of blue of the second order. The coloured portion of the film extended only 10 millimetres from the top. In from eight to 15 minutes from the moment of formation of the film, a black film appeared, and slowly extended downwards. The behaviour of the films under the influence of the current was now observed. With a solution of potash-soap and a film 40 millimetres long, through which the current was passed from the moment of its formation, it was found that broad bands of colour formed and spread with great rapidity, soon occupying the whole area of the film. After six minutes the current was 2·6 micro-amperes. In eleven minutes there was a ring of black, which increased in three minutes to 3 millimetres. Next, a film of 40 millimetres was taken, which had thinned until 2·5 millimetres of black were formed. Following the black was a band of deep blue. A downward current of 5·18 micro-amperes was applied. The blue changed to white, the black not being altered. After nine minutes the black was still of the same breadth, and the white had increased to 16 millimetres, the current being 4·06 micro-amperes. In two minutes after breaking the circuit the white had changed to black, the extent of which had become 19 millimetres, or nearly the whole length of the film. This and similar observations showed that a downward current had the remarkable effect of swiftly thinning that part of the film which was thicker than the black, but did not necessarily affect the latter. The film, however, was put into such a state that, on the cessation of the current, the development of the black proceeded at a rapid rate. With a downward current of 6·2 micro-amperes the black entirely disappeared after one minute, being replaced by white; and the current rose to 6·5 micro-amperes. The latter had the effect of destroying the black and increasing the conductivity of the film. With a film 30 millimetres long, to which a downward current of 24 micro-amperes was applied from the beginning, the white extended more than halfway down, after ten minutes, and the current fell to 2·5 micro-amperes. The circuit was then broken and the white turned to black so rapidly that the entire transformation was effected in less than one minute. Under the influence of the upward current the black was always destroyed, and, where previously existing, replaced by white; the current generally increased in intensity up to a certain limit. At certain stages of the film's existence a very feeble current was sufficient to destroy the black. One very interesting experiment was performed upon two films, each 30 millimetres long, which were formed side by side. The current was divided and passed up one and down the other film. The effect was most striking. In twelve minutes, when one of the films broke, there were 15 millimetres of black in the one, while the other was thick and colourless, and liquid was streaming from the top of it.

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ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 309.)

[*Errata.*—On line 18 of the last article, page 307, READ $\frac{1}{850}$ and $\frac{1}{800}$ for $\frac{1}{150}$ and $\frac{1}{200}$.]

It remains yet to be considered whether a machine constructed as shown in Fig. 1, but without iron, could excite itself—that is, act as a dynamo. The answer must be in the the negative, as can easily be shown. Suppose the coils *a*, *b*, *c*, *d*, were put in series with the armature wires *e f*, and admit for a moment that the principle of mutual accumulation, as in the ordinary dynamo, would come into action, what would happen? A weak current in the field wires would induce a proportionately weak current in the armature wires; this would reinforce the former, which would again act on the armature, and so on to infinity, since the induced current is always proportional to the inducing one and the resistance of the whole apparatus is a fixed and finite quantity. The above admission leads, therefore, to the absurd result that a dynamo without iron can give an infinite current, and we must conclude that no mutual accumulation can take place, and therefore the apparatus cannot act as a self-exciting generator of current. This follows, also, from a closer study of the interaction between the various wires. To simplify matters we will assume the most favourable case, viz., that all the lines between *a* and *d*, and similarly all the lines between *b* and *c* are eliminated, and only those passing vertically between *a* and *b* and *c* and *d* remain, which are all favourable for generating a current in the armature wires. On this supposition the current in *e* will be started the moment when this wire passes the radius connecting *a* with the centre. Now, the current starting in *e* reacts on the wire, *a* creating a current in the opposite direction, and therefore weakening the original current. The same takes place when *e* passes the other field wires, and the result is that no current can be generated. But if this reaction of the armature wire on the field wire could by some means be prevented, the machine could be made to work. To do this, it is required to prevent the lines of force round the armature wire from reaching the field wire, without, however, preventing the lines of force round the field wire from reaching the armature wire. The only method known at present for effecting this is by an iron screen interposed between the two sets of wires—in other words, by employing iron pole pieces. Here, then, we have two very good reasons for employing iron in the construction of field magnets—the first, as already stated at the end of the last article, is that the magnetic resistance in the path of the lines of force produced by the field wires is diminished, and a given amount of exciting power is made to yield a larger number of lines; and the second is that the iron protects or screens the field wire from reaction on the part of the armature wire.

Up to the present we have tacitly assumed the central space between the armature wires to contain only air or other non-magnetic substance, but it will be evident that if we fill it with iron, we shall still further reduce the resistance in the path of the lines, and get on that account also an increase in the number of lines which go across the armature. But since the electromotive force, and consequently also the current, depends on the number of lines of force (or, as it is sometimes put, on the strength of field) we arrive at the broad fact that to obtain the greatest electrical output with machines of the type described we should have a sufficient mass of iron both in the field-magnets and also in the armature. The same can be shown for machines of the Gramme type, whether the armature be cylindrical or ring shaped. It might, perhaps, be thought that, since this fact is so generally known, all the above arguments might well have been omitted, and these articles might have begun with the axiom, "In a good dynamo there should be plenty of iron." But then it would have been necessary to explain why; and that would have forced us to introduce at the beginning the question of magnets generally. Now such terms as "free magnetism," "strength of pole," "magnetic moment," "total magnetism," &c., which are generally employed when we talk of magnets, are very objectionable, because to different people they have a different meaning, and cannot be so easily fixed numerically as can the simple conception of lines of force. Moreover, the employment of a nomenclature itself somewhat indefinite must sooner or later lead to loose reasoning, and should be avoided on that ground alone if on no other. According to our way of looking at the question the proper function of the field magnets of a dynamo is not to have the greatest possible magnetic moment, or free magnetism, or total magnetism, &c., but simply to facilitate the creation of lines of force belonging to the field wire, and to protect the latter from reaction on the part of the armature wire. If, as a necessary consequence, the poles of the field magnets and other portions as well become strongly magnetic (as the word is usually understood), this is a result but not the cause of the lines of force.

It will be useful to see what connection exists between lines of force and the above terms relating to magnetism, at least as far as a definite meaning can be attached to them. In making the comparison we shall assume all the lines to have equal force, no matter how their number may vary in different places. According to this conception the free magnetism or strength of pole of a magnet would be represented by the number of lines emerging from that pole. The magnetic moment would be defined as the product of number of lines on either end of the magnet multiplied by the distance between the two surfaces at which the lines enter and leave the magnet. If the lines do not all enter and leave the magnet at the ends, but partly also at the sides, as is generally the case, the magnetic moment is the sum or integral of these products taken separately for each line or group of lines. Intensity of pole can be expressed as the number of lines emanating from one square inch of polar surface, and strength of field as the total number of lines passing between two opposite polar surfaces. In the same way the intensity of the field in any particular place is expressed as the number of lines of force passing through one square inch of cross section at that place. It should be remarked here that electro-magnetic measurements are generally given in C.-G.-S. units, but to make the formulæ given below directly applicable in the drawing office and workshop the inch has been retained as the unit of length.

In a dynamo those lines of force which are instrumental in producing E.M.F. pass between the polar surfaces and the armature; all other lines are useless or detrimental to the working of the machine. The greater the number of useful lines the higher will be the E.M.F. produced with a given number of coils on the armature and at a given speed. Our aim should therefore be to produce a maximum number of lines. The question now presents itself, how can the number of lines be calculated beforehand if the dimensions and other constructive particulars of a dynamo are known? Experimentally, the author has found that for low-exciting powers the number of useful lines can with a reasonable degree of approximation be expressed as the quotient between exciting power and magnetic resistance. This alone does, however, not solve the question; it merely shifts it over to the following problem:—How can the magnetic resistance of a given dynamo be computed? Before entering into this subject in detail it will be instructive to point out the analogy which exists between this conception of magnetic resistance and Ohm's law. In fact it is Ohm's law applied to the magnetic circuit. For electromotive force put exciting power, for current put number of lines of force running across the polar surfaces, and for electrical resistance put magnetic resistance, and the analogy is perfect. We can even go a step further, and establish an analogy between internal and external resistance as applied to a set of cells and to an electro-magnet.

Let in Fig. 2, A B and C D be two rows of cells placed opposite each other, and join the ends B and C by a wire of small resistance *r*, and the ends A and D, which we consider as the poles of the two sets of cells, by a somewhat greater resistance, R. Let there be *n* cells in each row, and let the internal resistance of each cell be ρ, and its electromotive force *e*. If the total difference of potential between A and D be E, the current flowing (if we have no leaks) will be

$$c = \frac{E}{R} = \frac{2ne}{2n\rho + r + R}$$

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Since we are only dealing with a difference of potential, we may fix the absolute potential of one point of the system at any convenient level. Say we assume the potential of D to be zero. Then the absolute potential will be

In C ..... $ne - cn\rho$
In B ..... $ne - cn\rho - cr$
In A ..... $2ne - 2cn\rho - cr$

Now, it will be evident that the potential in C must be greater than that in B, the difference being cr; and since the potential increases from B towards A and decreases from C towards

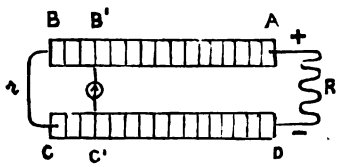

FIG. 2.

D, there must exist on the former row of cells somewhere a point B', where the potential is $ne - cn\rho - cr + \frac{1}{2}cr$, and on the latter row of cells somewhere a point C', where the potential is $ne - cn\rho - \frac{1}{2}cr$. If we join the points B' and C' by a galvanometer as shown, the latter will give no deflection, whilst if we shift the galvanometer with its attachments to the right or left of this position it will show a deflection in one direction or the other. The position of equilibrium will be the nearer to the poles the greater the resistance of r, and if it be desired to get a maximum of current through R, where it does useful work, the resistance of r should be as small as possible. Practically the cells between C' and C and between B and B' are useless.

Now for the analogy of the magnetic circuit. Let, in Fig. 3, A B C D be the magnet excited by coils as shown. The armature is placed between the poles A and D, and is traversed by lines running N — S, as indicated by the arrows. Let R be the resistance of the armature, and r that of the yoke B C, and the analogy will be apparent. In a perfect machine the lines should run right round inside the iron from R to S A B r C D N and back to R. In doing so the lines experience a certain resistance, partly due to having to leap across the air space between the poles and the core of the armature, partly due to the core itself, and partly due to the magnet. If we make the arms of the magnet long and thin we increase the internal resistance; and if we make the yoke r of small cross section we also increase the internal resistance. The formulæ given for the battery circuit are directly applicable in this case if by e we denote the exciting power per lineal inch of magnet core, by ρ the magnetic resistance of one inch of core, and by

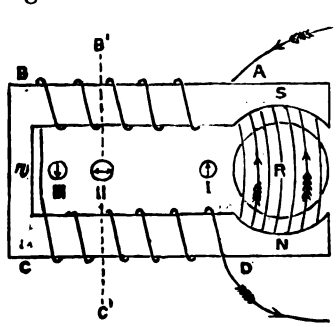

FIG. 3.

n its length in inches. If we place a small compass in position I, the N of the compass will point at arm A B, and if we move the compass to the left it will continue to point the same way, but with decreasing force, until a position II is reached, where the needle of the compass is undecided which way to point. In this position there are evidently no lines of force, or, if there be, they must run in all possible directions. If we move the compass still further to the left, the N will point towards C—that is, in the opposite direction to the first. The position II on line B' C' corresponds to our experiment with the galvanometer on the cells, the only difference being that here we have the air as a conducting medium, whilst there we had to touch the cells with the wires from the galvanometer to get an indication. The lines of force leak across from one arm to the other, and so influence the little compass. It will be easily understood that as far as the armature R is concerned, that portion of the winding which is to the left of the line B' C' is absolutely useless; its only use is to overcome the resistance of the yoke r. The position II can be found in any dynamo while at work. Take a small compass, such, for instance, as is made as an ornament for watch chains, and pass it slowly between the two arms from the armature towards the yoke. There will be found one position where the compass seems quite undecided which way to point. In cast-iron machines with thin yokes this position will be found several inches from the yoke, but in wrought-iron machines with very thick yokes it will be found so near the yoke that it is sometimes difficult to detect it at all. From what we have said just now about the coils to the left of the line B' C', it will be seen that machines with long magnets and thin yokes might be improved by shortening the magnets and joining them by much heavier yokes.

(TO BE CONTINUED.)

THE MOST ECONOMICAL POTENTIAL DIFFERENCE TO EMPLOY WITH INCANDESCENT LAMPS.*

BY PROFESSORS W. E. AYRTON, F.R.S., AND JOHN PERRY, M.E.

(CONTINUED FROM PAGE 309.)

Since writing the article in your issue for February 21st, one of our students, Mr. Robertson, has with praiseworthy energy been making some efficiency experiments on Edison lamps obtained from France, and by trial he has found some that give 16 candles at about 100 volts, and are therefore presumably of the same type as those employed in the life experiments given by M. Foussat in your issue for January 31st.

Mr. Robertson's experiments on one such lamp are as follow:—

TABLE I.

Candles or θ (v).	Volts or v.	Watts.	Candles or θ (v).	Volts or v.	Watts.
3 ...	84	... 56·62	18 ...	101·5	... 92·37
4 ...	87	... 63·51	20 ...	103·6	... 96·66
5 ...	87·8	... 66·03	22 ...	105·4	... 100·13
6 ...	90·5	... 69·05	24 ...	107·5	... 104·28
7 ...	93·5	... 75·74	26 ...	109·2	... 108·11
10 ...	96·75	... 79·34	28 ...	110	... 111·10
11 ...	97·61	... 81·01	30 ...	111·4	... 113·63
12 ...	98·04	... 82·35	35 ...	114	... 118·56
14 ...	98·9	... 85·55	40 ...	115·2	... 122·11
16 ...	100·6	... 90·54			

We are therefore now in a position to take up the problem in a more direct manner, without making any assumption beyond this—that Mr. Robertson's 16-candle 100-volt French Edison lamp is of the same kind as M. Foussat's 16-candle 100-volt French Edison lamp.

Solving the problem graphically in the way previously described, and using the same values of p, n, and H, viz., cost of a lamp, 5s.; number of hours of burning per year, 560; and annual cost of an electric horse-power for these 560 hours, £5, we obtain the curve. A A A (see diagram, p. 348) represent the cost per candle per year as regards renewal of lamps, B B B the cost per candle per year as regards power, and the resultant curve C C C the total cost per candle per year.

The minimum value of this cost appears from this curve C C C to be at about 101·4 volts, and to then equal about 11d. per candle per year.

If the potential difference be maintained constantly down at 98·7 volts, or up at 104 volts, then the cost becomes 1s. per candle per year. It will also be seen from the curves that the yearly cost for renewals of lamps is but a small fraction of the total yearly cost as long as we are using potential differ-

* Read at the Physical Society, February 28, 1885.

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ences of not more than about 100 volts; so that when using, with these lamps, this or a lower potential difference the actual sum paid for the lamps is not so very serious an item in the yearly lighting bill. But if, on the other hand, we maintain a potential difference of, say, 104 volts constantly at the terminals, then the lamp renewals represent, in our particular case, nearly one third of the yearly expenditure, and consequently any change in the price of lamps becomes extremely important.

We find that the simplest expression for the candle-power of this incandescent lamp in terms of volts is

$$\theta(v) = a\,(v-b)^3 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Thus, for example, it will be found that if the cube roots of the values of $\theta(v)$ given in the preceding table are plotted with the corresponding values of v as co-ordinates of points on

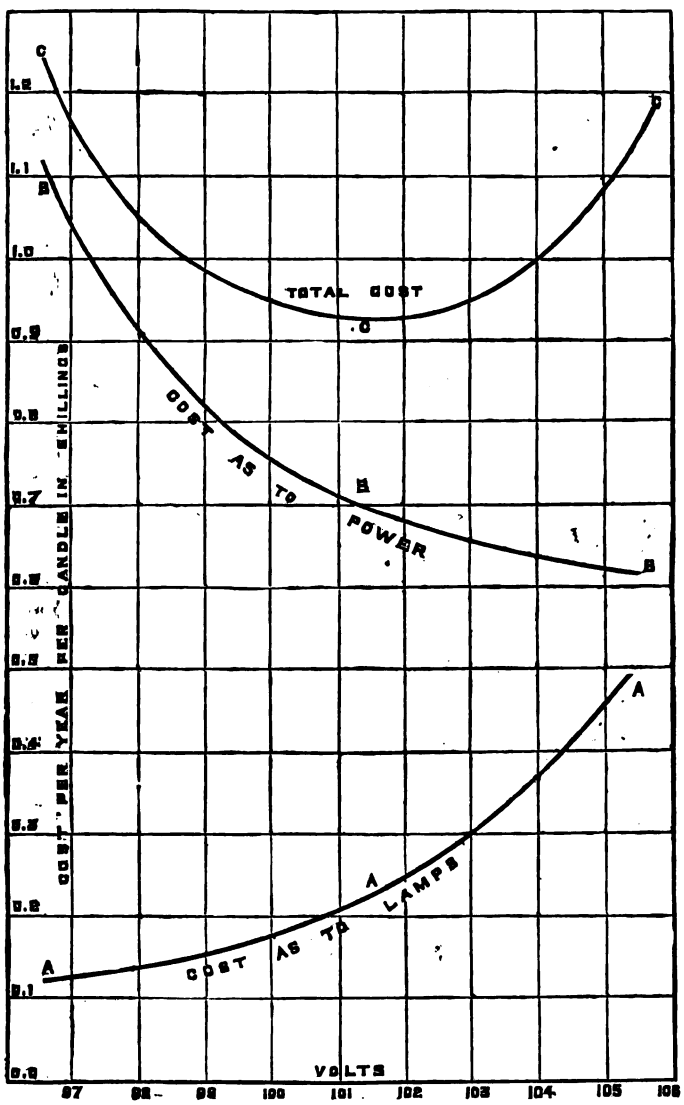

DIAGRAM FOR A 16 CANDLE 100 VOLT EDISON LAMP.

squared paper, the points lie in no regular curve so nearly as on a straight line, discrepancies being apparently due to an error of observation, which errors of observation follow a periodic law which may be of interest physiologically. Or it may be that the two slight waves in the curve on each side of the straight line are due to there being a place of contra reflexure at the part of the curve when we are examining it.

For the particular lamp in question we find that

$$a = 0{\cdot}0002621$$
$$b = 62{\cdot}12$$

or if the law remains true for a less number of volts than 84, which is the lowest used in this experiment, then when $v = 62{\cdot}12$ the light, or $\theta(v)$ becomes nought.

We do not, however, find that the cube roots of the candle-power of all sorts of incandescent lamps follow a line function of the difference of potential at their terminals, for examining the results of experiments that have been made with various types of lamps, we find that with the first four of the following set of lamps, the law

$$\sqrt[3]{\theta(v)} \propto v - b$$

is very nearly true.

1. A Lane Fox lamp ..... from 50 to 80 volts.
2. A British Electric Light Company's lamp ..... „ 50 to 68 „
3. An Edison "7 B" 8-candle lamp ... „ 45 to 63 „
4. A old Swan lamp..... „ 40 to 64 „
5. A low resistance 8-candle Swan lamp „ 16 to 40 „

whereas with the next five lamps it is not so true, although for half the range the law might be regarded as true in all the cases.

6. A Maxim lamp ..... from 42 to 57 volts
7. A Maxim lamp ..... „ 35 to 110 „
8. An old form Swan lamp ..... „ 25 to 54 „
9. A high resistance Swan lamp ..... „ 45 to 90 „
10. An Edison B 8-candle lamp..... „ 36 to 85 „

We may here mention that we have found the following plan very useful in helping us to draw correctly a curve at a place where there is a sudden bend and an absence of points, determined from experiments, to guide us in drawing the curve. Instead of plotting x and y, and obtaining a curve which it would be very difficult to draw correctly, we may be using some easily derived function of y obtain points which obviously lie on a curve which it is easy to draw. Thus we may plot $\sqrt{y}$ and x, or $y^{\frac{1}{3}}$ and x, or $\log y$ and x. When the curve connecting y and x is not asymptotic to the axis of x, but to some line parallel to this axis, it is obvious that there is a greater likelihood of obtaining simple curves by plotting $\sqrt{y \pm a}$ and x, or $(y \pm a)^{\frac{1}{3}}$ and x, or $\log(y \pm a)$ and x, where a is some constant obtainable by inspection, than by simply plotting the function of y above.

The following table gives M. Foussat's lives in terms of v and the corresponding values which we have calculated of $\log f(v)$, $\log \theta(v)$, and of $\log f(v)\,\theta(v)$, from the values of $\theta(v)$ given in the previous table :—

TABLE II.

v.	$f(v)$.	$\log f(v)$.	$\log \theta(v)$.	$\log f(v)\,\theta(v)$
95	3595	3·5557	0·9729	4·5286
96	2751	3·4395	1·0119	4·4514
97	2135	3·3294	1·0485	4·3779
98	1645	3·2161	1·0851	4·3012
99	1277	3·1062	1·1199	4·2261
100	1000	3·0000	1·1556	4·1556
101	785	2·8949	1·1898	4·0847
102	601	2·7789	1·2216	4·0005
103	477	2·6785	1·2531	3·9316
104	375	2·5740	1·2852	3·8592
105	284	2·4533	1·3152	3·7685

When $\log f(v)\,\theta(v)$ and v are plotted as co-ordinates of points these points are found to lie so nearly on a straight line that the formula

$$\frac{1}{f(v)\,\theta(v)} = 10^{0{\cdot}07545\,v - 11{\cdot}697} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

is found to be true with considerable accuracy, and such a formula lends itself with great ease to calculation.

It is quite true that we might have obtained a still more accurate formula than (2), since, as published by Mr. Wright, one of the members of our class, in *The Electrician* for February 21st, the logarithm of the life of a lamp is shown to be a line function of the difference of potentials at which it is worked.

We may, in fact, with this particular type of lamp, put

$$f(v) = 10^{14 - 0{\cdot}11\,v} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

with very great accuracy indeed.

Combining this with (1), we obtain as a more accurate formula

$$\frac{1}{f(v)\,\theta(v)} = \frac{1}{a}\,10^{0{\cdot}11\,v - 14}\,(v-b)^{-3} \quad . \quad . \quad . \quad (4)$$

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But, unfortunately, this more accurate formula does not lend itself to mathematical calculation, whereas that given in (2) is very suitable for this, and has a sufficient degree of accuracy for our purpose. In using (2) we are really using for the candle-power

$$\theta(v) = 10^{0.03455\,v - 2.303} \quad . \quad . \quad . \quad . \quad . \quad (5)$$

instead of (1).

It will be also found that from 95 to 105 volts, the range of volts given in Table II., the values of $\phi(v)$ or volts per candle-power, when corrected for errors of observation, satisfy with considerable accuracy the equation

$$\phi(v) = 3{\cdot}7 + 10^{8.007 - 0.07667\,v} \quad . \quad . \quad . \quad (6)$$

If, however, we take the whole range of values given in Table I., then it will be found that the equation

$$\phi(v) = 2 + 10^{4.424 - 0.03793\,v} \quad . \quad . \quad . \quad . \quad (7)$$

is better satisfied than (6).

The following Table III. gives the numbers we have actually employed in making these calculations.

TABLE III.

v.	$\sqrt[3]{\theta(v)}$ corrected.	$\theta(v)$ corrected.	Watts corrected.	Watts per c.-p. $\phi(v)$.	$\log\{\phi(v) - 2\}$
84	1·4	2·744	56	20·408	1·2650
86	1·53	3·582	60·15	16·79	1·1700
88	1·66	4·574	64·25	14·27	1·0888
90	1·786	5·7	68·4	12·0	1·0000
92	1·914	7·0	72·6	10·37	·9227
94	2·044	8·55	76·85	9·0	·8451
96	2·175	10·28	81	7·882	·7695
98	2·3	12·167	85·15	7·0	·6990
100	2·428	14·24	89·3	6·271	·6305
102	2·556	16·69	93·5	5·6	·5563
104	2·682	19·29	97·8	5·07	·4871
106	2·81	22·188	101·9	4·593	·4138
108	2·94	25·412	106	4·172	·3369
110	3·065	28·79	110·1	3·824	·2610
112	3·195	32·61	114·25	3·504	·1772
114	3·32	36·594	118·3	3·233	·0910

Using (6) and (2), the total cost of one candle per year is

$$p\,n\,10^{0.07545\,v - 11.697} + \frac{H}{746}\left(3{\cdot}7 + 10^{8.007 - 0.07667\,v}\right).$$

This is a minimum when

$$v = 110{\cdot}66 + 6{\cdot}574 \log \frac{H}{p\,n}.$$

Hence, taking $p = 0{\cdot}25$, $n = 560$, $H = £5$, we find

$$v = 101{\cdot}15 \text{ volts.}$$

Using (7) and (2), we shall find in the same way that the minimum is obtained when

$$v = 101{\cdot}46 \text{ volts,}$$

which minimum values of v agree very closely with that previously determined graphically.

One very important problem in connection with incandescent lamps, and one that cannot yet be regarded as solved, is the determination of the life of a lamp for any given number of volts from experiments made either on the efficiencies at several different potentials, or from experiments on the life made at so high a potential difference that the life will be short, and the experiment made therefore in a comparatively short time.

If, however, an expression of the form

$$f(v) = 10^{a - bv}$$

can be regarded as representing with sufficient accuracy the law of life for all types of incandescent lamps, then if sufficient experiments be made with a number of lamps at each of two different potential differences, to enable us to determine the average life at each of these potential differences, the constant a and b can be calculated from the equation, and hence the value of $f(v)$, the life, calculated for any other potential difference.

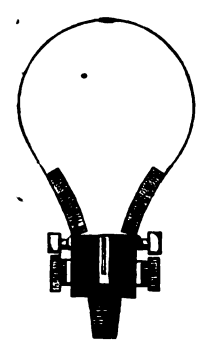
In connection with this investigation we have endeavoured, with the aid of one of our assistants, Mr. Walmsley, to ascertain whether some form of ordinary cheap candles can be used, at any rate for rough photometric measurements, in place of the much dearer standard candles, and as far as the following results obtained with seven candles, selected at random from a packet of No. 8 sperm candles, go, it would seem that these candles do not differ so very much more in intensity from one another than standard candles are said to do. Further experiments, however, on the matter must of course be made before a decision can be arrived at; but, in the meantime, the following results may be interesting. This particular type of candle (No. 8 sperm), costing 11d. per lb., was selected because such candles resembled in thickness the standard candles which we have been accustomed to use, and which cost 2s. 9d. per lb.

	Grammes for wax burnt per hour.	Light on terms of that emitted by the standard candle.
Standard candle.....	7·82	1·00
1st sperm candle	Doubtful	1·14 (?)
2nd „ „	6·102	1·00
3rd „ „	7·188	1·00
4th „ „	7·29	1·02
5th „ „	7·1	1·02
6th „ „	6·84	1·05
7th „ „	6·66	0·99

These tests of candle power were not made with any very high degree of accuracy, but the comparison of these No. 8 sperm candles with the standard was carried out with probably quite as much accuracy as is employed in making ordinary commercial experiments on the luminosity of incandescent lamps.

THE COX-WALKER LAMP HOLDER.

The new holder for incandescent lamps, which forms the subject of our illustration, has already been described in the pages of *The Electrician*. It consists of a block of insulating



material, three quarters of an inch square, with a deep groove across the middle, in which two metallic nipping plates (which would be better if they were lined with platinum), acted upon by two clamping screws, are fixed. These receive the loops of the lamp, and are connected to the upper terminal screws shown in the illustration. To insert the lamp it is only necessary to put the point of the glass bulb in the small loop at the bottom of the brass wire, place the connecting loops of the lamp between the nipping plates of the holder, and to screw up the clamps so as to ensure good electrical contact, an operation which would not occupy ten seconds.

We venture to suggest that the line of shadow cast by the brass wire loop encircling the lamp will detract somewhat from its usefulness; in other respects the holder is to be highly commended.

PRIMERS OF ELECTRICITY.—These Primers, which had a large sale at the recent Philadelphia Exhibition, can now be obtained at the office of *The Electrician*, price 1s.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

ELECTRICITY FOR WORKING RAILWAY SIGNALS AND POINTS.

It was with great surprise we read the announcement three or four weeks ago that a somewhat hackneyed subject was to be discussed before the Society of Telegraph Engineers. We had printed in our columns as long ago as last March (*The Electrician*, March 22nd, 1884) a full description of Mr. Currie's appliances for working signals and points on railways by means of his long-pull magnets, with ample illustrations; and later in the year (November 8th) we reprinted a paper delivered by Mr. Timmis before the Institute of Mechanical Engineers, dealing more in detail with the electrical and mechanical merits of the same invention. Since then it appears to have been re-delivered in the provinces; and now, lastly, it finds its way to the place where, one would have thought, it should have made its appearance first. The paper read before this Society is almost word for word identical with that printed by us in November. So far as these circumstances imply that, on the one hand, Mr. Timmis maintains an undisturbed faith in the value of the subject he has so energetically taken up; and on the other that the Council of Telegraph Engineers and Electricians think it a good thing, and that we cannot have too much of it, the inventor and promoter have reason to congratulate themselves; though the paucity of subjects for discussion which this incident seems to betoken is not a matter on which we can congratulate the Society.

Nevertheless, the acceptance of the paper was amply justified by the lively interest it awakened, and the prolonged discussion it evoked during the whole of the next following meeting; and that the subject is one of vast importance is of course unquestionable. If electro-magnetism can be safely employed to supersede the present system of hand-pulled signals and points, it is obvious that a great boon would be conferred on railway management, and a great addition made to the safety of railway travelling—to say nothing of the railway servants, whose duties in attending to points and signals are often attended with the greatest jeopardy to life and limb.

Electricity has long performed most valuable functions in ministering to the block system, and in generally informing the signalmen of the whereabouts of the traffic. But up till now the only means of communicating, so to speak, with the men in charge of the trains has been by hand-pulled semaphores, which can only be worked for a limited distance because of mechanical difficulties inseparable from the use of such appliances. In the case of points the operation is even more limited and risky. Moreover, the direction and angles in which the lever pulls can be exerted with effect are confined within narrow limits, necessitating as a general rule a congestion of traffic in close proximity to the signal-box, in order to bring the lines and signals within the area commanded by the mechanical operations of the signalmen. If the distances could be extended there would be a corresponding saving of signal-boxes and men, as well as a manifest advantage to the guards and engine-drivers. And if the signalling were independent of direction, curve, or angle there might be greater economy in laying down the permanent way.

That these obvious considerations have hitherto not resulted in a further application of electricity to such requirements is due probably to the repeated failure of attempts to obtain powerful electro-magnets except with an expenditure of enormous battery power or to get a long pull with any sort of uniformity of action or with an action capable of being controlled. Mr. Currie has certainly made a valuable addition to the mechanical capacity of electro-magnetism by the invention now under consideration. A reference to the descriptions and illustrations in our pages above-mentioned will sufficiently explain its principle. In combination with a counterweight acting at a suitably-varying leverage an approximately equal pull—we quote Mr. Timmis's words—is obtained through a considerable range, and violence of contact in the closing of the disc upon the magnet is avoided. By suitably adjusting the several proportions of the various parts the pull can be so greatly varied both in force and range that it can be adapted to meet almost any requirements. By a further adaptation of the same principle, placing two single magnets in combination endwise, control over three positions is obtained; and the inventor claims this as a useful application for signal arms that are required to stand at the three positions of danger, caution, and line clear. The magnetic attraction is said to be more evenly distributed, over a longer range, while the initial pull is stronger and acts at a greater distance than in any other electro-magnet of the same weight and with the same current.

The electrical criticisms offered during the discussion before the Society of Telegraph Engineers may be described as either merciful or friendly, according as one may estimate the practical value of the invention. Some mistrust was shown as to the figures adduced relating to the cost of maintaining the

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signals in working order. The result of calculations on theoretical bases were a little too fanciful for the credulity of the audience; and when next we hear of Mr. Timmis's paper we hope to learn what the railway people say on the subject, if indeed the experiments at Swansea are not quite gratuitous. One or two electrical engineers connected with railway signalling were dubious about the safety of a system dependent, it would seem, on electrical connections and combinations somewhat delicate and complicated; whilst others thought that the expense would be too great—whether the initial expense or the cost of maintenance was not made quite clear. But those who had seen the appliances on view expressed themselves highly gratified with the system; and as to its practical working there is the important fact that it has been in use on a line of railway at Swansea for several months without the occurrence of a single hitch or accident of any kind whatsoever.

One objection to the system is that it involves, or, at all events, is most efficient with, the use of secondary batteries, which is obviously not an economical, nor, except near large central establishments, a practical source of power. We take leave also to demur to the suggestion that the same batteries may be used to maintain the lights in the signal lamps and at the points. Impracticable suggestions such as these rather tend to arouse misgivings as to the soundness of the main scheme. But promoters would probably not be promoters if they did not possess a lively fancy. Whatever its merits, however—and it has many—Mr. Currie's invention will not suffer for want of being well trumpeted; and we are glad of it. If the possibility of working railway signals and points by electromagnetism be demonstrated by Mr. Timmis's indomitable perseverance, we may hope to see, if not this, some better system sooner or later meet with general acceptance.

CORRESPONDENCE.

ELECTRO-MAGNETS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: "Volt-Ampere" is rather hard on me. When I give him shortly the result of two or three years' past work, he grumbles because I do not give also a year or two's work which has yet to be done. But I will do my best. I will answer his last question first. (I assume that u is a misprint for μ).

"Consequently $\frac{l}{\mu}$, as the first term of ρ, does not seem to get that alteration we are accustomed (with short magnets as regards their diameters) to see."

I believe this is incorrect. My observations on bars show that between such limits as $\mathfrak{B} = 2{,}000$ and $\mathfrak{B} = 15{,}000$ the magnetic resistance ρ is practically constant—*i.e.*, the magnetism is nearly proportional to the excitation. This is even more true for short bars than long ones. For very short bars the resistance of the metal forms so small a part of that of the whole circuit that the whole resistance is nearly independent of the permeability of the metal. The fact is generally admitted.

As to the magnet core 5½in. long and 2½in. diameter, I think the formula would not be quite correct for this; but the resistance would be greater than that given by the formula. I have computed roughly from such data as I have how many ampere turns it would take to raise $\mathfrak{B}$ in the equatorial section of such a magnet to such a value as 18,000, and I find a very large number, something like 20,000 ampere turns. I find it difficult to understand how a cylindrical core, without pole pieces, as described, can be saturated by 5,000 or 6,000 ampere turns; for my Gramme cores are not so far from the same dimensions, and have pole pieces which reduce the shape resistance to almost nothing compared to the resistance of the cylinder, and they take fully 5,000 ampere turns when the machine is in full work. And I have other reasons. I think there must be some mistake. Are there not pole pieces? How was the amount of saturation ascertained? And how were the ampere turns measured?—Yours, &c., R. H. M. BOSANQUET.

St. John's College, Oxford, 1st March, 1885.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I write in the interests of numbers of people situated like myself, never knowing from day to day what lamps are coming next.

I have altered the lampholders here about four times for 200 lamps, and twice for another 200 lamps, and yet the end has not come! I was delighted to use the Swan socket lamps, but unfortunately they were so badly made that some fitted and others would not, the result being that many broke in the hand. Then came the pretty vitrite fittings; but here every third lamp broke off at the vitrite pins, and were rendered useless. Many also had bad contacts between the platinum wires and the cap. Out of every 25 lamps about eight have gone wrong in this way. The loops seem the best so far; and notwithstanding all that has been said against the side loops of the high resistance lamps they have many advantages, because the spring is not outside the hooks in the holder, and short-circuiting is almost impossible. I would suggest that lamps should be made like the side loop lamps, only with a straight pull, as in the present make; and for the vitrite bottom lamps better contacts should be made, and pins of metal cast in the vitrite for fitting in the bayonet joint.—Yours, &c., DAVID SALOMONS.

Broomhill, Tunbridge Wells, 3rd March, 1885.

[On looking again at the specimen of vitrite fittings forwarded to us, we find it broken as described by Sir David Salomons. A second specimen we have seen has likewise gone. This seems to point to careless manufacture, as the material itself looks sound and good.—ED. *E.*]

NEW UNITS FOR OLD ONES; COST, £(?)0,000.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It seems hardly to be realised by the electrical world that our standards of measurement are getting into a state of hopeless confusion. This is perhaps partly because the error of the B.A. units is looked upon as very small, whereas it is really large enough to cause, for instance, perceptible errors in running glow lamps. The electrical engineer may readily realise the value of 1·3 per cent. by imagining his income tax raised threepence, if he has an income. And it is partly, perhaps, because these matters are settled by men of such calibre that we are naturally inclined to accept their recommendations gratefully and without question. But it may be as well sometimes to throw off the respect due to such men as the members of the Electrical Congress, and to look at their doings without pink spectacles.

At present there are no less than three different values of the volt and ohm in use. First, there are the B.A. volt and ohm, or 1864 units, which are now in almost universal use. Then there are the ohm and volt according to Lord Rayleigh's determination, and now there are the "legal" ohm and volt, so-called because they are not legal, which were got by taking the mean of a lot of determinations without respect to the probable accuracy of each, and wiping off a decimal for no obvious reason. The accurate determination of the ohm is a matter of very great scientific interest; but is it at all reasonable to change our practical and commercial ohm and volt because they are wrong for others also wrong? Though much nearer the theoretical units than were the B.A. units of 1864, even the Rayleigh volt and ohm must in the nature of things be wrong, and the ohm must eventually be the resistance of one particular piece of wire, and that particular resistance cannot be made exactly correct, though the error may have only a scientific, and not commercial, consequence like the present error.

What are the advantages of changing our ohm and volt? First, our units, as multiples of the C.-G.-S. units by powers

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of ten, will be correct. This is not quite true; they will only be somewhere about right, the error being periodically varied by congresses, and the temperature labels for resistance boxes being published like Stock Exchange quotations. This accuracy seems to be considered of great importance by some, but is a matter of no practical importance. Then the alteration will make 746 watts equal to one horse-power. But it is just as easy to use 755, or, perhaps better, 756 as a coefficient. Another advantage would be that when mechanical engineers measure power in watts, their watt will agree with the electrical watt. But is there the remotest chance of mechanical engineers adopting the C.-G.-S. units? If they give up measuring work in foot-pounds they will measure it probably in kilogrammetres, not in joules or ergs multiplied by other powers of ten. From a sentimental point of view the kilogrammetre is in one way more consistent than the C.-G.-S. unit; for though the gramme may now be defined as the mass to which unit force gives unit acceleration, it was the weight of a C.-C. of water, so that while the kilogrammetre involves gravity and not acceleration, the erg and joule involve both. The watt and joule are themselves inconveniently small for engineers. If they ever take up the kilogrammetre, their units will be only ·7 per cent. out as round multiples of the B.A. units, so that a coefficient need only be used for exact work; but if the ohm be made approximately correct they will be nearly 2 per cent. out, ·981 being the coefficient. But if their standards were to be at the mercy of international congresses, who may alter them and make them somewhere about right at any odd time, they will probably stick to their horse-power, foot-pound, B.W.G., and their cherished nominal horse-power till doomsday.

What are the disadvantages of the new units? First, endless confusion. Even now, though the B.A. units are 20 years old, we still come across Siemens units. More than this, the average writer on electrolysis tells you he gets this effect or that by "passing the current of ten Smee cells;" and the average French chemist uses the old notation, and measures his E.M.F. not even in Daniells, but in calories. How long, then, must it take before the confusion due to three pairs of units with the same names disappear? The question really resolves itself into, what are we to do about our resistance boxes? We cannot use coefficients. Instruments in common use must be direct reading, and must involve no calculations, whatever may be permissible in the laboratory. It would generally be cheaper to put a bridge box aside and get a new one than to use a coefficient. The bridge box might be altered by altering one side of the bridge itself in the proportion of 1 : 0·9886; but at the best that would be patchwork.* When the number of boxes in use is remembered, it is evident the mere cost of alterations will cost us many thousands of pounds. Is it worth while paying this merely to be able to say, "Our ohm is somewhere about right, for exact error see latest determination of the ohm?" The potential galvanometers now in use do not matter much, they are mostly wrong "anyhow." Then, again, every time a resistance box or anything else accurately measured is wanted, the seller will have to ask, like a bank clerk "How will you have it?" Unfortunately, members of the congress are not the people who have to make resistance boxes, and cannot even be said to use instruments commercially, or out of the laboratory. When a congress resolves on a S. C. of melting platinum as unit of light, the men who use light standards daily treat it, as Mr. Ward says, with "skorn," and go and buy a Referee burner from Mr. Sugg, and either calibrate their standard glow-lamp from it, or use it itself with proper precautions. It is a popular delusion that glow-lamps are always tested against standard candles. If a practical standard is derived from the Violle standard, and left so that copies may be made, of course no confusion arises; but if a new standard is made, nearly a candle-power, and called a candle, there will be more trouble. Perhaps, in settling standards of light an insignificant industry called the gas trade may be considered. Any one who knows anything of the gas trade may imagine how eagerly a standard of light derived from a S. C. of melting platinum will be snapped up and put into universal use, especially if there is a chance of a new determination of the candle every now and again.

Of course, it must be remembered that if the Rayleigh, or even the "legal" ohm, be adopted, whenever a congress decides on a new value it will be so close that the temperature labels only of resistance boxes will have to be altered. But while writing as a Philistine, and before replacing the pink spectacles, a suggestion occurs. Why should not the International Congress have their resistance boxes made in "legal" ohms, but use them at such a low temperature that they fit the B.A. ohm? If they hire Mr. Cook or Mr. Virgil to conduct them personally to the district Dante describes as so very, very cool, and use their resistance boxes there, would any one complain of the new change?—Yours, &c.,

March 4, 1885. JAS. SWINBURNE.

[Mr. Swinburne is only urging what we have maintained long ago, and we venture to hope that many practical men will support these views.—ED. *E.*]

* A bridge box to compensate for temperature might be made by using different metals in the bridge. Thus platinum silver coils, and platinum silver on the line side of the bridge, with gold silver alloy on the other side of the bridge, might be nearly compensating.

PERSONAL SAFETY AND ELECTRIC CURRENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to offer my best thanks to Mr. Trotter for the information he has so kindly furnished with reference to the fatal accident at The Healtheries. I should be glad if the physiological actions could be traced.

Does the violent contractions of the muscles of the chest cause a stoppage of the flow of venous blood to the heart, and does death thereby ensue, or is the effect similar to that of strangulation?

Another point on which we should also be clear is—did 1,200 volts, applied to the hands of a healthy man, kill him; or did he receive a higher E.M.F., due to an *extra* current?

Evidently the destructive properties of any machine may be materially modified, as M. D'Arsonval has shown, by the winding.

A dynamo whose E.M.F. was produced by very large magnets, with comparatively few turns of wire, would be less dangerous than one having the same E.M.F, produced by smaller magnets, a smaller current, and a larger number of turns of wire round the magnets.

Hoping that the physiological question will be attacked by some of those gentlemen who are conversant with the subject, and who have the time.—Yours, &c.,

SYDNEY F. WALKER.

195, Severn-road, Cardiff, 4th March, 1885.

THE SKRIVANOV BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I shall feel greatly obliged if any of your readers can give me particulars of the Skrivanov battery, and how to construct it, its power and duration of useful work. Are the used-up materials reconvertible?—Yours, &c., W. FORBES.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

The discussion on Mr. J. A. TIMMIS'S paper relating to the "Working of Railway Signals and Points by Electro-magnets," read on the 12th February, took place at the Society's meeting on Thursday, February 26th, Mr. Spagnoletti, president, in the chair. Mr. LANKESTER opened the discussion by stating that from the engineering point of view Mr. Currie's invention—described by Mr. Timmis—appeared to answer its purpose admirably for dispensing with long and heavy levers. He could offer no opinion, however, on its electrical merits, as he was not an electrician. Mr. LANGDON, while expressing a general approval of the long-pull magnet for distant signals, thought that its application to the general system of block signalling was of doubtful utility. Speaking as an electrician, he feared that the electrical arrangements were complicated, and would require constant supervision. He also thought the system would not recommend itself to the railway companies for its economy. Professor HUGHES described the various devices adopted during the past 20 or 30 years for obtaining long-pull electro-magnets, and the uses to which

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some of them had been put, especially on French railways. Illustrating these diagramatically, Professor Hughes also drew attention to the method adopted by himself of using a supplementary permanent magnet under the electro-magnet for obtaining a powerful blow to release the detent in the Hughes' type printing instrument with the aid of only a very feeble current. Turning to Mr. Currie's invention, he could see on theoretical grounds that great care had been bestowed in arriving at the best form of electro-magnet for the object intended. Sir CHARLES BRIGHT also described some examples of long-pull magnets which had come under his notice. Mr. A. J. ADAMS, who thought the employment of electrical batteries uncertain and dangerous, suggested the utilisation of water, available at most stations, for obtaining hydraulic power with which to work the signals. After some remarks from Mr. CONRAD COOKE, Mr. W. H. PREECE expressed a decided opinion that Mr. Currie's system would be admirably adapted for long-distance signal working, but doubted the advantage of employing it for near signalling, which could be quite as well done by hand. He had thoroughly examined the apparatus on the inventor's premises, and had greatly admired it. He had also heard a good report of it from Swansea, where it has been at work now for several months. Professor AYRTON thought there was a needless expenditure of force in working the long-pull magnet solely with the view of instantaneously raising the signal arm, whereas the arm could be raised gradually, but quickly, by means of a motor with far less expenditure of electrical power—a method of working railway signals which Professor Perry and he had already given some attention to. At this point in the discussion, a long communication from Mr. S. F. Walker was read, criticising Mr. Timmis's conclusions, but referring chiefly to things that had been said at a meeting held at Nottingham. Some other gentlemen, whose names did not transpire, pointed out that the Board of Trade's regulation forbidding the employment of signals at distances further than 150 yards was inconvenient and expensive. Mr. Currie's invention, if practicable and safe, would have the effect of extending this limitation; and Mr. CURRIE, the inventor, as well as Mr. Timmis, both of whom replied to criticisms, stated that the Board of Trade would only be too glad to extend the distance providing it could be done with safety. Mr. Currie's system would probably be the means of dispensing with a number of signal boxes, at every one of which three men had to be employed; and it had this great advantage, that it gave three positions even at long distances, which no hand-worked signalling could do. The congestion of rails now necessitated by the existing hand-pulled signalling would also be done away with by working the signals electrically, as the current would travel in any direction or at any angles you pleased.

The usual vote of thanks concluded the discussion, which, having been unusually prolonged, Sir DAVID SALOMONS' promised paper, "On Constant Electromotive Force in an Electric Light Circuit," was postponed till the next meeting.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

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1. The subject chosen for the present discussion illustrates in a remarkable way the need for such conversations. It is scarcely credible, at the present rate of progress, that eighty-four years after the discovery of the voltaic pile, opinion should still be utterly divided as to the seat of the main E.M.F. in it. I venture to hope that it may now be decided, and a substantial agreement arrived at with respect to it. My business is to open the discussion; but it so happens that for some seven or eight years I have believed myself to see more or less clearly to the root of this particular matter, and a laborious review of the literature of the subject has only strengthened my conviction. Having, therefore, strong and definite views I can hardly help letting them appear; and without assuming prematurely that these views are agreed with, they may yet serve as a link with which to connect the facts and the multifarious observations thereon.

In the course of my reading on the subject I have found only two great and epoch-making papers, that of Volta in 1801, and that of Sir William Thomson in 1851. The other contributions are some of them keen, like those of Faraday and Clerk Maxwell; some of them laborious, like those of Hankel and Ayrton and Perry; but none contain anything essentially and powerfully new except those two: unless, indeed, we include in the subject the immensely important phenomena of Seebeck and of Peltier, and Faraday's fundamental law of electro-chemical decomposition.

Volta* showed that when two metals were put into contact and separated, the insulated one was charged with electricity sufficient to make gold leaves diverge. He also stated that the contact force between any two metals was independent of intermediate metals, so that the metals could be arranged in a definite numerical series; and he gave the first series of the kind :—

Zn	Pb	Sn	Fe	Cu	Ag.
5	1	1	2	3	

Moreover, he started a hypothesis to account for the action, a sort of impulsion or attraction of electricity by matter—an idea subsequently elaborated by Helmholtz. Fabroni† objected to Volta's explanation of his experiment. He denied contact force, and considered that the electricity was developed by chemical action.

Then the fight began, and lasted on and off some half century. On the one side were Volta, Davy, Pfaff, Péclet, Marianini, Buff, Fechner, Zamboni, Matteucci, and Kohlrausch. On the other were Fabroni, Wollaston, Parrot, Œrsted, Ritchie, Pouillet, Schönbein, Becquerel, De la Rive, and Faraday.

It was not all fighting; part of it resulted in a more thorough investigation of voltaic phenomena; and very often the original point of dispute was lost sight of, and Volta's fact itself was doubted in the eagerness to disprove Volta's explanation. The experiments of Pfaff and Péclet‡, however, fairly well established the correctness of his observation; and Kohlrausch showed how, by means of a Daniell's cell combined with a condenser, to measure Volta forces absolutely, thus inventing a method which has been employed with modifications by Hankel, by Gerland, by Clifton, by Ayrton and Perry, by Von Zahn, and by most other experimenters on the subject.§

Wherever electrostatic methods were employed, and where the electroscope was the instrument of research, contact theorists had it all their own way; and it was only by apparent effort and twisting of experiments that chemical theorists could maintain their ground. But when electric currents were dealt with, and the galvanometer used, then the chemists had their turn, and they showed most conclusively that no mere contact could maintain a current unless heat disappeared or chemical action occurred: a fact obvious enough to us to-day on the principles so laboriously and finally established by Joule. By means of the galvanometer, the contact theory was so belaboured by Faraday that it ultimately seemed to give up the ghost, and the chemical doctrines triumphed. So much so, that Volta's original fact, in spite of the evidence which had been

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* Professor O. J. Lodge contributes the first of five chapters on this subject to the current number of the *Philosophical Magazine*, with the following letter :—"The accompanying tract is an expansion of a paper drawn up as the opening of a discussion on Contact Electricity by Section A of the British Association at the Montreal meeting. It is in five portions or chapters. The first of these [printed this month] is mainly historical; in the second and third portions theoretical views are considered, and my own are given at some length in accordance with the kind advice of Sir W. Thomson; the two remaining chapters are occupied with cognate thermo-electric phenomena, with the theory of the simple voltaic cell, which singularly enough is pretty complicated and very little understood, and with a discussion on the size of atoms. Although the paper is being printed in the annual volume of the Association, it has been suggested that a further publication of it might be useful in order that physicists may have a better and more leisurely opportunity of contributing to the discussion of a matter which must have occupied the attention of every one more or less, which branches out into several interesting and important developments, and which, as a matter of controversy, has remained singularly long unsettled. I will therefore ask you to find room for it in your journal, in the hope that the discussion may be there conveniently continued and properly closed."

* Volta, *Gehler's Wörtenbuch*, iv. p. 616. See also a carefully-edited version, *Annales de Chim.* 1 ser. xl. p. 225 (1801).

† Fabroni, *Journal de Physique de l'Abbé Rozier*, xlix. p. 348.

‡ Péclet on the Contact of Good Conductors: *Comptes Rendus*, 1838, p. 930; Pogg. *Ann.* xlvi. 1839, p. 346; *Ann. de Chim.* 1842 and 1841, 3 ser. ii. p. 233.

Pfaff, Letter to Gay Lussac: *Ann. de Chim.* 2 ser. xli. p. 236 (1829).—Plaff: For and against the production of Electricity by Chemical Processes, as a consequence of some experiments on the E.M.F. of liquids and metals: Pogg. *Ann.* xli. 1840, pp. 110 and 197.—Pfaff: Experimentum crucis in favour of the Contact Theory: Pogg. *Ann.* liii. 1841, p. 303. This crux is on p. 306, and consists in substituting $ZnSO_4$ for H_2SO_4 in a Grove cell, and showing that the current through a thin wire galvanometer is stronger than before. This, he says, leaves no further shift or evasion (Ausflucht) for the chemical theory. It is a fact we have grown accustomed to, but it *is* rather surprising, that the E.M.F. given by $ZnSO_4$ should be even higher than that given by H_2SO_4. A convenient "Ausflucht" could nevertheless be provided for the chemical theory by pointing out that the combustion heat Zn, $2NO_3$ is greater than Zn, $SO_4 - H_2SO_4 + 2(H, NO_3)$, if indeed the fact be so. Another shift is to talk about basic sulphate and the sourness of $ZnSO_4$; another is to use the word "dissociation."

§ Kohlrausch's method consisted in bringing the plates of the two metals close together, connecting them by a wire for an instant, separating them, and putting one into connection with a Dellman electrometer, the other with the earth. The observation is repeated with a Daniell in the connecting wire, first one way, then the other. Thus three equations are obtained,

$$M/M' = k\alpha,\quad D + M/M' = k\beta,\quad D - M/M' = k\gamma\ ;$$

whence

$$M/M' = \frac{B-\gamma}{B+\gamma}D,\ \text{or}\ \frac{\alpha}{\beta-\alpha}D.$$

(Pogg. *Ann.* vols. lxxv. p. 88, lxxxii. pp. 1 and 40, and lxxxviii. p. 465, 1851 and 1853). He gets his results much lower than later experimenters; only ½ a volt for Zn/Cu, and ·58 for Zn/Pt.

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accumulated, was again doubted; and one finds in text-books culled from this period statements that Volta must have had wet fingers, or that he rubbed the plates together, or that there was moisture in the air. Also hints are given that films existed on the plate, that squeezed coats of varnish or lacquer might produce some electricity, and so on. It was pointed out, moreover, by De la Rive*, how minute a trace of chemical action could produce how much electricity, and how little electricity could affect an electroscope. But it is to be noted than any chemical action caused by damp on the plates, or moisture in the air, would be of the nature of local action, and local action is not a satisfactory producer of manageable electricity. Sir Humphry Davy is very clear on this head. He shows that chemical action need produce no electricity, instancing the burning of iron nitre on charcoal, potash and acid in a crucible or an electroscope, &c.; a plate of zinc placed on mercury and separated is found positive, but if left long enough to amalgamate, the compound shows no signs of electricity. Davy's views are singularly advanced, and are worth quoting.†

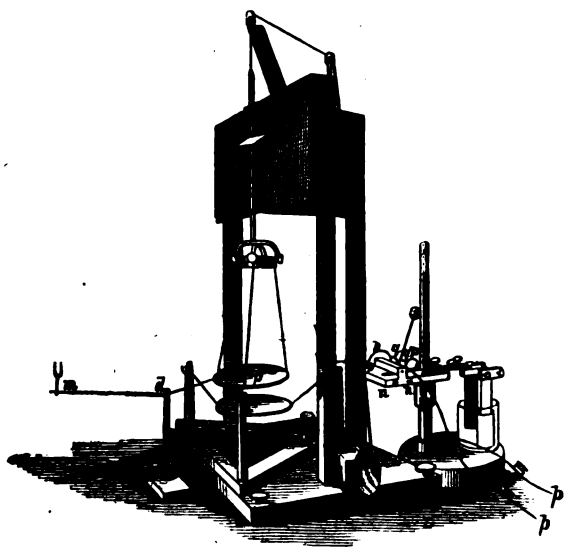

FIG. 1.—Kohlrausch's Early Form of Condenser.

Both the plates are insulated by silk threads. The fixed wire, *d*, with which the raised plate comes into contact, leads to a Dellman electrometer. The connections are arranged for determining the "electroscopic tension" on the poles of an open battery, to see if it is the same as the E.M.F. (See Pogg. *Ann.* 1848, vol. lxxv. pp. 88 and 220.)

This apparatus he also used to measure the Volta effect between two metals, his classical memoir on the subject being in Poggendorff's *Annalen*, 1851, vol. lxxxii. p. 1. Later he improved the condenser, bringing it into the form shown in the following figure.

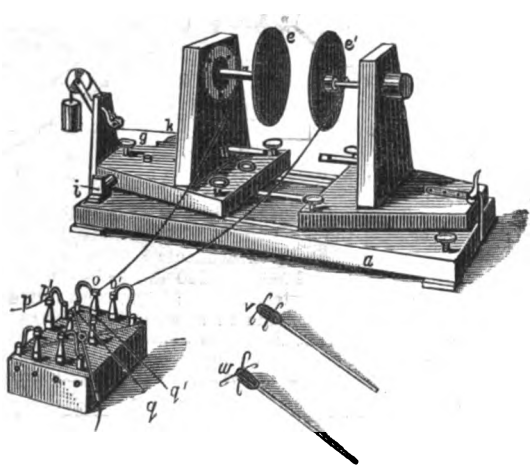

FIG. 2.—Kohlrausch's Later Form of Condenser.
(See Pogg. *Ann.* 1853, vol. lxxxviii. p. 464.)

Quite detached from any connection with the controversy, because at that time quite unintellibible to all but one or two here and there, two papers appeared in 1851 by the President of this Section, which were the triumph and apotheosis of the chemical theory of the source of the current in the voltaic cell.* In one of these papers (that on "Electrolysis") it is irrefutably established, on the basis of the conservation of energy, that, making exception of such irreversible effects as are not readily brought into calculation, and allowing for certain possible reversible effects to be investigated thermo-electrically, the E.M.F. of a cell is not only dependent on the chemical action going on, but is calculable numerically in absolute measure on purely chemical data supplied provisionally by Dr. Andrews. It is proper to say, however, that this brilliant theory is avowedly based on the laborious and acute experimental work of Joule on the conservation of energy in the voltaic circuit†.

In the other of the two papers (that on "Thermo-electricity") it was shown that, from the fact that a current absorbed or generated heat at a metallic junction, an E.M.F. was necessarily situated there—in other words, that the Peltier effect necessitated the previously-discovered Seebeck one.

The establishment of the conservation of energy, by Joule, for ever placed beyond doubt the fact that the energy of the electric current produced by a battery was due to, and was the equivalent of, the chemical actions going on there; but it was supposed, and is still supposed (though, as I venture to think, quite erroneously), to leave untouched the question as to the precise seat of the E.M.F. in a battery.

However that may be, the success of the chemical theory of the electric current naturally caused it to be still more certainly assumed that the apparent contact force of Volta could also be accounted for by accidental chemical action, and that without some chemical action somewhere no Volta effect could be produced. This, also, I believe to be quite false; provided always that the phrase "chemical action" be used in its ordinary sense as meaning combination, and that the word "action" be not explained away as meaning anything whatever.

2. The triumph of the chemical theorists with regard to the Volta effect was, however, shortlived, for, from 1860, the invention of the quadrant electrometer put into the hands of electrostatic experimenters a far more refined and delicate instrument than could have been thought possible a few years before; and the illustrious inventor of that instru-

* De la Rive: *Traité d'électricité*, ii. p. 776; *Annales de Chimie*, xxxix. p. 311 (1828).

† Davy, Bakerian Lecture, 1806 (see Phil. Trans. 1807, p. 39. :—"As the chemical attraction between two bodies seems to be destroyed by giving one of them an electrical state different from that which it naturally possesses. . . . . so it may be increased by exalting its natural energy. Thus, while zinc is incapable of combining with oxygen when negatively electrified in the circuit even by a feeble power, silver easily unites to it when positively electrified. . . . . Among the substances that combine chemically, all those, the electrical energies of which are well known, exhibit opposite electrical states. . . . . In the present state of our knowledge it would be useless to attempt to speculate on the remote cause of the electrical energy, or the reason why different bodies after being brought into contact should be found differently electrified; its relation to chemical affinity is, however, sufficiently evident. May it not be identical with it, and an essential property of matter?"—Page 44: "The great tendency of the attraction of the different chemical agents by the positive and negative surfaces in the Voltaic apparatus seems to be to restore the electrical equilibrium. . . . The electrical energies of the metals with regard to each other or the substance dissolved in the water, seems to be the cause that disturbs the equilibrium, and the chemical changes the cause that tends to restore the equilibrium; and the phenomena most probably depend on their joint agency." He then gives a very Voltaic account of the action of the pile—much in agreement with Sir Wm. Thomson; and endeavours to reconcile chemical and contact theorists by pointing out how essential a part chemical action plays in the production of a *current*, a most clear-sighted thing to do at that date. One more sentence may be quoted from this remarkable paper, though it is not quite so striking as the preceding. —Page 49: "These ideas are evidently directly in contradiction to the opinions advanced by Fabroni, and which in the early state of the investigation appeared extremely probable—viz., that chemical changes are the *primary* cause of the phenomena of Galvanism. Before the experiments of M. Volta on the electricity excited by mere contact of metals were published, I had to a certain extent adopted this opinion; but the new fact immediately proved that another power must necessarily be concerned, for it was not possible to refer the electricity exhibited by the opposition of metallic surfaces to any chemical alterations, particularly as the effect is more distinct in a dry atmosphere, in which even the most oxidizable metals do not change, than in a moist one, in which many metals undergo oxidation."

* Sir W. Thomson:—1. "On the Mechanical Theory of Electrolysis and the Applications of the Principle of Mechanical Effect to the Measurement of Electromotive Forces in Absolute Units," Phil. Mag., December, 1858. Reprint of Mathematical and Physical Papers, vol. i., pp. 472 and 490. 2. "On the Dynamical Theory of Heat, part vi. Thermoelectric Currents:" Proc. R. S. Edin. Dec. 1851; Trans. R. S. Edin. 1854; Math. and Phys. Papers, vol. i., pp. 232 and 316.

Helmholtz also clearly applied the conservation of energy to voltaic circuits in his memoir *Die Erhaltung der Kraft*. read before the Physical Society of Berlin, 23rd July, 1847. In this powerful memoir Professor Helmholtz sails placidly through a great part of physics, applying to various phenomena the then new principle of the conservation of energy. He regards all action as occurring at a distance, and shows, as is well known, that, on this hypothesis, central forces are the necessary and sufficient condition of conserved energy. This part may now be regarded as superseded; but in the more special portions, among other things, he develops the mechanical theory of the E.M.F. of voltaic cells, of thermo-electric piles, and of magneto-machines, anticipating in many respects the somewhat later though independent work of Sir W. Thomson on these subjects.

Prof. Helmholtz's memoir is easily accessible through a translation, by J[ohn] T[yndall], which appeared, in May, 1853, in the "new series" of 'Scientific Memoirs,' issued by Taylor and Francis.

† Joule:—"On Heat evolved in Metals and during Electrolysis," Phil. Mag. [3] xix. p. 260 (1841); "On the Electric Origin of the Heat of Combustion," *ibid.* xx. p. 98 and xxii. p. 204; "On the Heat Disengaged in Chemical Combination," Phil. Mag. [4] iii. p. 481. See also Reprint of Joule's papers by the Physical Society of London (Taylor and Francis).

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ment himself for ever put the truth of Volta's phenomenon beyond doubt, by the most simple and beautiful device of suspending a charged torsion arm over a zinc-copper junction. By comparing the deflection so produced with that caused by a Daniell cell, an absolute measure of the so-called contact force was made; and it was shown that, uniting the copper and zinc by a drop of water, instead of by a metal, no deflection was produced. It was also shown that the deflection was greatest when the zinc was clean and the copper oxidised.*

But Sir William Thomson went further than this: he sounded a theoretic note, and in a sentence revived the whole controversy about the seat of power in the pile. The sentence is this:—"For nearly two years I have felt quite sure that the proper explanation of voltaic action in the common voltaic arrangement is something very near Volta's, which fell into discredit because Volta or his followers neglected the principle of the conservation of force. I now think it quite certain that two metals dipped into one electrolytic liquid will (when polarisation is done away with) be at the same potential." And then he goes on to one of those brilliant and extraordinary speculations characteristics of no one else, and applies this apparent contact force to determine a lower limit to the size of atoms—an application obviously of transcendent interest, and of more importance than all the previous outcome of contact discussions put together.†

The whole subject now acquired a fresh interest, and the new series of experimental determinations of contact force began.

3. Hankel's and Gerland's measurements belong to this period in point of date (1861-69), though in method and motive they probably are the outcome of the earlier period.‡ Hankel uses a modified Kohlrausch method and a Bohnenberger or Hankel electroscope; his special merit is the determination of metal-liquid contact-forces without introducing blotting paper, glass, or fingers, as the earlier experimenters had done.

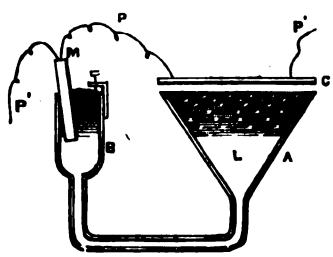

FIG 3.—Hankel's Arrangement for Observing the Volta Effect between a Metal and a Liquid.

The liquid, L, is in a funnel-tube, A, B; C is a copper plate, and M the metal under observation. First, p touches C for an instant, then C is raised and made to touch p', which leads to a Hankel electrometer.

This gives $\quad Cu/M + M/L = k\alpha.$

Then the liquid is run out of the funnel, a plate of the metal M is placed on its mouth, and the experiment repeated.

This gives $\quad Cu/M = k\beta.$

To eliminate k substitute a plate of zinc for M, and get

$$Cu/Zn = k\gamma.$$

Then, finally, $\quad M/L = \dfrac{\alpha - \beta}{\gamma} Cu/Zn.$

In all these expressions air contact-forces are, as usual, neglected. But it is very tempting to try if, by inceasing the number of such equations, one cannot calculate some metal/air contact forces. Thus the special case when M is copper gives one more equation. We can then take zinc instead of M, and can also make the condenser-plate of zinc instead of copper, and so on; but we get no forwarder, fresh unknowns appear as fast as additional equations, and some of the equations are liable to degenerate into identities.

So far back as 1824 Becquerel* attempted the investigation of metal-liquid contacts; and Buff† made some measurements in 1842, but his results are scarcely likely to be reliable considering the poor experimental resources of that date.

Professor Clifton employed Kohlrausch's method in 1877, using a Thomson electrometer and a Clark cell as standard of E.M.F. He has only published a preliminary paper,‡ in which he overlooks minutiæ such as change of contact-force by time and adventitious circumstances. When he touches on theory he agrees with Thomson. Professor Clifton has examined the Volta effects for the substances ordinarily used in batteries with great care, and has probably elicited the maximum of accuracy possible to his method. He gives the E.M.F. of numerous virgin cells in which no current has circulated.

Ayrton and Perry in 1876 devised in Japan a very ingenious but somewhat unwieldy modification of Kohlrausch's method, and with the help of students carried out a most extensive and laborious series of determinations of metal/metal, metal/liquid, and liquid/liquid contacts.§

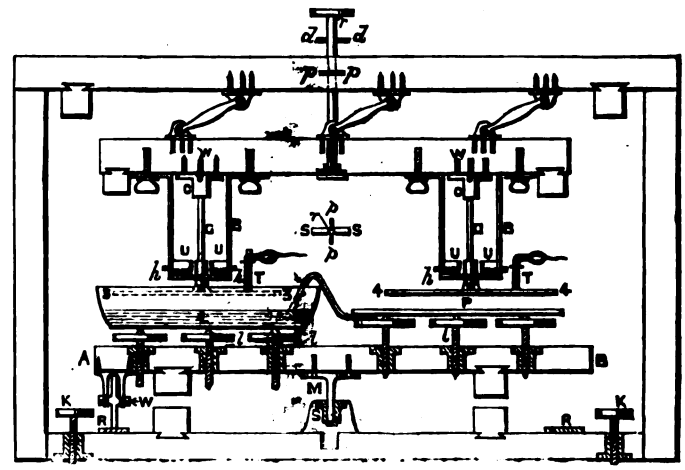

FIG. 4.—Ayrton and Perry's Apparatus for measuring the Volta effect with all sorts of substances.

The substances are arranged on the lower platform, as, for instance, the metal and liquid shown in the figure at P and L. The platform, A B, is capable of rotation through 180° on its railway, R. 3 and 4 are carefully insulated gilt plates fixed to a bar which can be raised and lowered. The experiment consists in lowering these plates close to the surface to be tested, and connecting them with each other for a short time; then raise them, rotate the platform through 180°, lower again, and connect them with a quadrant electrometer.

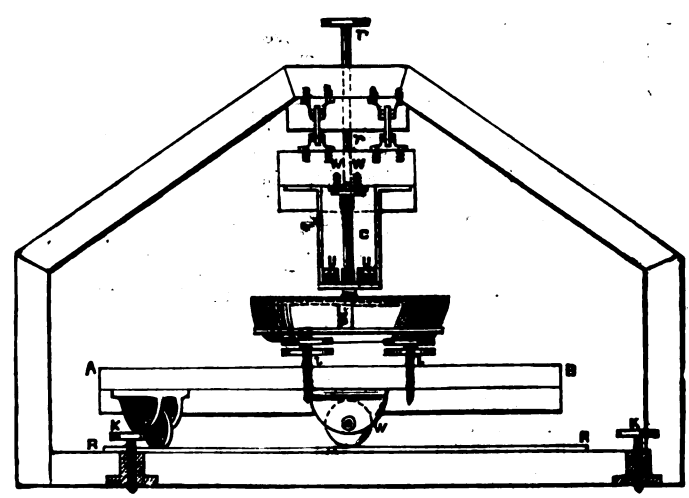

FIG. 5.—End view of Ayrton and Perry's Apparatus.

On the appearance of Clifton's paper the year after, they issued a strongly-worded claim in respect both of priority and completeness—a claim which seems to me well established, for their results are the most comprehensive yet obtained, and the energy needed to devise, construct,

* Proc. Lit. and Phil. Soc. Manchester. Letter from Prof. W. Thomson to the president, Dr. Joule, Jan. 21, 1862: "New Proof of Contact-Electricity." See reprint of papers on Electrostatics and Magnetism, p. 317.

† "There cannot be a doubt that the whole theory is simply chemical action at a distance. Zinc and copper connected by a metal wire attract each other from any distance, so do platinum plates coated with oxygen and hydrogen respectively. I can now tell the amount of the force, and calculate how great a proportion of chemical affinity is used up electrolytically before two such discs come within any specified small distance down to a limit within which molecular heterogeneousness becomes sensible. This of course gives a definite limit for the size of atoms."—*Letter to Dr. Joule*, 1862, *cited above*. See also Thomson and Tait, Nat. Phil., Part II., Appendix F.

‡ Hankel, *Electr. Untersuchungen, Abh. der königl. Sächs. Gesellschaft, math.-phys. Klasse*, 1861 and 1865, See also Pogg. *Ann.* cxv. p. 57, and cxxvi. pp. 286 and 440; cxxxi. p. 607.

Gerland, "On the E.M.F. between Water and some Metals," Pogg. *Ann.* cxxxiii. 1868, p. 513; cxxxvii. 1869, p. 552. In his second paper, to get over the air effect, Gerland joins two metals through a galvanometer, and then dipping them into a liquid, observes the first swing of the needle. He also compensates the E.M.F. by Poggendorff's method. He thus determines the value of

$$M/M' + M'/Liquid + Liquid/M.$$

* Becquerel, *Ann. de Chimie*, 1824. He puts the liquid in a copper capsule on the plate of an electroscope, and connected it with the condenser plate by his fingers.

† Buff, Liebig's, *Ann. Chemu. Pharm.* 1842. He made the lower plate of his condenser the metal to be examined; on it he placed glass, and then filter paper soaked in the liquid, which he connected with the metal plate by a wire of the same metal.

‡ Clifton, Proc. Royal Soc. xxvi. p. 299 (1877).

§ Ayrton and Perry, Brit. Assoc. Glasgow, 1876. No abstract printed. Part I., Proc. Royal Soc. 1877 or 1878 is a preliminary account. Part II. describes a metallic voltaic cell of magnesium and platinum and mercury, also some experiments on electrolytes of high resistance. Part III. Phil. Trans. 1880, is the complete account of their published electroscopic experiments.

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and use such an apparatus as the one they depict must have been immense.* A convenient summary of their numbers is to be found in Everett's "Units," second edition. The main result achieved by them is the experimental establishment of the summation law for all substances (this is not to be confused with Volta's summation or series law, which is only applicable to metals), viz., that the total E.M.F. of a closed circuit of any number of substances may be reckoned by adding up the Volta forces observed electrostatically for every pair of substances in contact. This law is, it seems to me, for reasons given later (§. 7), very probable theoretically; but still it was quite essential to have it experimentally established, especially as Ayrton and Perry point out that it is often called in question without good ground. The establishment of this law is, I say, perhaps their main work in this matter, besides the observation of the Volta effect for various difficult substances, especially liquids and liquids.

Clifton arrives at the same conclusion with regard to summation, and gives handy diagrams, reproduced in Jenkins's "Electricity," of the contact-force at the different junctions. My own opinion is that the intended and obvious significance of these diagrams is theoretically wrong, but they embody certain experimental results conveniently, and they can be interpreted properly.

Both Clifton and Ayrton and Perry appear to believe in the great constancy of the value Zn/Cu. Clifton gives it as ·8516 volt ("Quelle précision!" somewhat sarcastically ejaculates Pellat, who himself finds it to vary between ·63 and ·92). Ayrton and Perry assert that it is more constant than a Daniell. I believe that both Professor Clifton and Professors Ayrton and Perry have made several experiments besides those recorded in their communications to the Royal Society; but as they have not been published, I can give no account of them.

Among the Thèses presented to the Faculty of Science in Paris in 1881 we find an important memoir by Pellat†, which reviews the whole position very clearly, and records a series of determinations of Volta force among metals, determinations which are evidently the most accurate and satisfactory yet made. He adopts the capital experimental method of neutralising the charge of a condenser by a Poggendorff or compensation method, and thus converts Kohlrausch's into a null method, for which a very sensitive electroscope is all that is needed. The plates of the two metals set face to face are connected, not directly, but by a greater or less length of a graduated wire conveying a current; and the position of the slider on the wire is adjusted by continually separating the plates and testing until no charge at all is found. The step of potential on the wire is then precisely equal to the "contact-force" between the plates; for this would have caused a charge in a similar but uncompensated condenser, and the step of potential on the wire has neutralised it.

(TO BE CONTINUED.)

THE DRAWBAUGH TELEPHONE CASE.

AMERICAN BELL TELEPHONE COMPANY AGAINST THE PEOPLE'S TELEPHONE COMPANY ET AL.

(CONCLUDED FROM PAGE 338.)

It remains to consider what effect is to be given to the testimony of the multitude of witnesses who have been produced to substantiate the defence.

Disregarding the testimony which is merely hearsay, and therefore incompetent as evidence of the main fact, the testimony of many other witnesses is overthrown by the palpable improbability of their statements, or by the contradictions between their statements and those of other witnesses for the defendants upon substantive points, or by successful attacks upon their accuracy in the rebutting testimony of the complainant.

There still remains a formidable number of witnesses who testify to seeing or using Drawbaugh's talking machine, and some of whom identify particular exhibits as the instruments which they saw or tried.

No doubt is entertained that Drawbaugh was experimenting at an early period with telephones or phonographs. He knew about the phonograph or phonautograph of Scott as early as in 1863. The membrane diaphragm excited by sonorous waves and the electric mechanism of the phonograph were not novelties, and, among the diversity of inventive possibilities, had probably attracted his interest. Prior to 1869 Dr. Van Der Weyde had made public experiments with the Reis telephone at the city of New York, and others had made like experiments elsewhere. In May, 1869, a full description of the instrument and of the experiments was published in the newspaper, *The Manufacturer and Builder*, treating it as a highly interesting curiosity, which contained the germ of great practical purposes. Whether other newspapers noticed the experiments or not is not shown, nor is it shown that Drawbaugh saw the article in *The Manufacturer and Builder*. It would be difficult to prove the circumstance if he did see it. Some such publication probably stimulated him to experiment. If he made a sketch of the mechanism at the start, the material for it was at hand. As is stated by Mr. Benjamin, it has been asserted of the Reis instrument that certain sounds of the human voice can be transmitted by it, but in truth these are merely fragmentary reproductions of vocal sounds, and the transmission of articulate speech could not be effected because it was constructed on the make and break principle, instead of on that of the undulatory, unbroken current.

It is not strange to any reader of the autobiography that Drawbaugh should have taken up the telephone. That he, and those about him, should have treated it as a talking machine is entirely natural. That his talking machine as late as in 1876 bore a striking resemblance to the Reis telephone is shown by Mr. Shapley's testimony, a witness who noticed the resemblance and loaned Drawbaugh a copy of the *Scientific American* describing it.

There is enough here to explain Drawbaugh's declarations to his neighbours about the talking machine he was inventing, and to excite the curiosity of the community. A careful reading of the proofs render it easy of belief that the witnesses who testify about casual visits to his shop, which occurred many years before their testimony was delivered, and to cursory tests of his instruments on those occasions, have confused the fragmentary and incoherent articulation of such an apparatus with the hearing of distinct words and sentences. When witnesses undertake (as many of them do) to give the exact word or sentence heard in the instrument five or ten years before, when their attention was not called to the subject afterwards, no hesitation is felt in rejecting such statements as utterly incredible. It may be charitably inferred that such a witness has confused his recollection with more recent impressions. As will hereafter be shown the proofs demonstrate that most of the witnesses who testify to having heard distinctly and coherently through the talking machine, all those who indicate the exhibits B, F, and C as the instruments, are mistaken if they are truthful. If Drawbaugh was a charlatan he may have assisted in deluding them, and the proofs show that between 1872 and 1874 a string telephone was in his brother's shop, in the village. The fact that he never attempted to exhibit his machine outside of his shop, where it could be used between points some considerable distance apart, and where its real capacity could be readily observed, is significant in this connection.

The more important testimony is that by which it is sought to identify the several exhibits, and show their existence at times consistent with theory of the natural evolution of the invention. The identification of particular exhibits as seen by the witnesses among the various objects of curiosity at Drawbaugh's shop several years before they testify is necessarily unreliable when it is attempted by observers who had no knowledge of the mode of operation or of the infernal organisation of the instruments. Such witnesses could not appreciate what they saw even if they examined the instruments. Most of the witnesses belong to this class. Indeed, the greater portion of them do not profess to identify the exhibits positively. Some are more certain than others that particular exhibits are the instruments they saw. Exhibits F, B, and C are fragmentary remains of instruments, and their value depends upon Drawbaugh's description of the operative parts that no longer exist. Scores of witnesses testify to seeing the teacup device resembling Exhibit F, and the tin can device resembling Exhibit B, but the identification of the other exhibits prior to the date of Bell's patent is comparatively feeble.

The appearance of Exhibits F, B, and C is sufficiently peculiar and distinctive to impress the memory of those who saw them. On the other hand the other exhibits are not of this character, and all that ordinarily the witnesses can safely say of them is that five years or more before testifying they think they saw or used a small walnut box externally resembling I or A or E or D.

It may be said generally of all the testimony of the witnesses who attempt to identify exhibits, that it is mainly valuable when it proceeds from those who used the instruments which they think they remember, and obtained results. They must remember the results obtained much better than the minor differences of appearance presented by the instruments. Granting that Exhibits F, B, and C would be likely to be remembered, what shall be said of the value of the testimony of scores of witnesses who state that they tested these instruments, or saw others test them, and they articulated perfectly, when it appears by the most authentic test that these instruments were incapable of such articulation.

In March, 1882, after most of the proofs in the case had been taken, a test was made of the capacity of the exhibits to transmit speech in the presence of the counsel and the experts for the respective parties. It is not accurate to say a test was made of the exhibits, but reproductions of F, B, and C were made by Drawbaugh, and, as rehabilitated by him, were used for the test. Whether these were honest reproductions no one can tell, but such as they were they were experimented with by Drawbaugh before they were subjected to the test. Whatever else that test demonstrated, it proved that articulate speech could not have been practically communicated through Exhibits F, B, and C, at Drawbaugh's shop or under similar conditions; and that only fragmentary or incoherent speech could be occasionally and exceptionally rendered by the reproduced instruments which had been experimented with privately before the public test. The proofs show that all along to 1878 Drawbaugh exhibited his earlier instruments F and B to spectators, and used them as his talking machine, sometimes showing or using both together, and sometimes one of them. The testimony of the defendants' witnesses, Springer, Moore, Musser, and Bayler is pertinent upon this point, and has been referred to. How is it to be explained that he used these crude instruments in 1875 and 1876 as his talking machine if he had the better instruments, especially such instruments as E and D? But in view of the fact now shown that these earlier exhibits are incapable of satisfactory articulation, what confidence can be placed in the rest of the testimony produced to identify exhibits? If the witnesses are mistaken in identifying these very characteristic instruments, and in recalling the results obtained through them, little reliance can be placed upon the identification of the other instruments, or upon the statement of the results which the witnesses think were obtained through them. If these witnesses are mistaken in the dates which they fix for the occasions they speak of, their testimony can be reconciled with all the probabilities of the case. And the reasonable explanation of their testimony is that those witnesses who really saw or used the latter exhibits did so in 1876, 1877, 1878, and later, instead of on earlier occasions.

* Ayrton and Perry: Letter published in 1877 by Meiklejohn (Yokohama).

† Thèses présentées à la Faculté des Sciences de Paris, pour obtenir le Grade de Docteur-ès-Sciences Physiques, par M. H. Pellat, Professeur de Physique au Lycée Louis le Grand, No. 461; Juin 22, 1881. See also *Journal de Physique*, 1881, xvi., p. 68, and May, 1880: "Différence de potential des couches électriques qui recouvrent deux métaux en contact."

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The proofs on both sides lead to general conclusions that Drawbaugh was not an original inventor of the speaking telephone, but had been an experimenter without obtaining practical results until the introduction of the instruments into Harrisburg. It is very probable that after reading in the *Scientific American*, loaned by Mr. Shapley, in October, 1876, the article purporting to describe Bell's telephone, but which really described better the Reis apparatus, he undertook to improve his old devices. At that time, or after, he had examined the telephone instruments at Harrisburg, and carried one of them home to study, he may have altered the organisation of his instrument, and made the intermediate exhibits between F and D. If he exhibited them at his shop, and was able to transmit speech through them, this fact will account for the testimony of the witnesses who identify those exhibits, and may be mistaken as to the time they saw them. The real history of his talking machine is known only to himself, and it will not be profitable to conjecture when he made the advanced instruments which he claims to have made in February, 1875, and the later instruments.

It may be that in discrediting his narrative and rejecting the theory of the facts which rest upon it, the value of the corroborative testimony has been under-estimated. However this may be, no doubt is entertained as to the conclusion which should be reached upon the proofs.

Succinctly stated most favourably for the defendants, the case is this: One hundred witnesses more or less testify that on one or more occasions which took place from five to ten years before they think they saw this or that device used as a talking machine; they are ignorant of the principle and of the mechanical construction of the instruments, but they heard speech through them perfectly well, and through one set of instruments as well as the other. This case is met on the part of the complainants by proof that the instruments which most of the witnesses think they saw and heard through were incapable of being heard through in the manner described by them, and further, that the man who knew all about the capacity of his instruments never attempted to use them in a manner which would demonstrate their efficiency and commercial value; and on the contrary, for ten years after he could have patented them, and for five years after they were mechanically perfect, knowing all the time that a fortune awaited the patentee, and with no obstacles in his way, did not move, but calmly saw another obtain a patent and reap the fame and profit of the invention.

Without regard to other features of the case it is sufficient to say that the defence is not established so as to remove a fair doubt of its truth; and such doubt is fatal.

The observation of an eminent commentator may be quoted as apposite to the case: "No form of judicial evidence is infallible, however strong in itself; the degree of assurance resulting from it amounts only to an infinitely high degree of probability, and perhaps as many erroneous judgments have taken place on false or mistaken direct testimony as on presumptive proof." Best's Evidence, section 468.

A decree is ordered for complainant.

COMPANIES' MEETINGS.

Telegraph Construction and Maintenance Company (Limited).

The twenty-first ordinary general meeting of this Company was held on the 3rd inst., at the offices, 38, Old Broad-street, under the presidency of Sir Daniel Gooch, Bart., M.P.

The MANAGER (Mr. William Shuter) read the notice convening the meeting.

The CHAIRMAN: Gentlemen, the first resolution I have to propose is, "That the report and accounts to the 31st of December, 1884, submitted to this meeting be and the same are hereby received and adopted, and that a dividend of 36s. a share, in addition to the 12s. interest or interim dividend paid on June 30th, 1884, be paid upon all the shares of the Company for the year ended December 31st, 1884, and that such dividend be paid free of income-tax."

The MANAGING DIRECTOR (Vice-Admiral Sir George H. Richards, C.B., F.R.S.) seconded the motion.

The CHAIRMAN: Before putting the resolution I will just call your attention to a few facts mentioned in this report. Fortunately in this Company we have not to make long speeches. The report will show you that we have manufactured and laid (some of it was manufactured in the previous year) 875 miles of cable for the Eastern Extension Telegraph Company, to connect Saigon with Tonquin in the China Sea. That was laid successfully in February last. The Brazilian Submarine Telegraph Company's duplicate lines between Madeira and St. Vincent, and between the latter island and Pernambuco, part of which were manufactured in 1883, amounting in all to 3,030 miles, were laid between the months of March and July, and three repairs were effected in that Company's original cables during the same time. The Direct Spanish Company's duplicate cable between the Lizard and Bilboa, 473 miles in length, was laid during the month of May. A cable, 40 miles in length, has been laid across the Strait of Sunda (between Java and Sumatra) to replace the one destroyed by the volcanic eruption of 1883. Sundry lengths of cable, amounting to about 660 miles, have also been laid in the Australian and China Seas, to make good the existing lines of the Eastern Extension Telegraph Company, the portions thus renewed having been picked up. These services were carried out at various times between the months of February and August. Several short lengths of cable have been manufactured during the year for several telegraph companies; the German Union Telegraph Company's cable between Hamburg and Heligoland has been repaired; and in the month of December, the "Sunk" Light vessel at the mouth of the Thames was connected by a cable with the Postal Telegraph Office at Walton-on-the-Naze, as an experiment, for the Corporation of the Trinity House. The "Sunk," as perhaps you remember, is a light ship, and it has been the attempt of our officers to enable a communication to be made between the light ship and the shore in order to effect telegraphic communication. I daresay many of you were at the Exhibition last year at Kensington, and may have seen the model of the ship and appliances then proposed. That ship has been connected with the shore. Unfortunately we have had more trouble than we expected, and the thing has not up to the present moment been a perfect success; but the ship is there now, and we are beginning again now with the view of trying to remedy the defects. I hope our efforts will be successful. I am sure we must all be satisfied if we are able to carry out such a scheme as that, because it would be a very important thing to connect the different light ships on the coast with the land lines. We cannot promise success, but we know that our officers are doing their best, and have to a certain extent succeeded. Then we have also connected the Fastnet Lighthouse with the shore, and that was done during very bad weather. The consequence was, we were not able properly to land the cable on the rock on which the lighthouse stands, and it chafed across the edge of the rock and became broken; but we do not think there is much risk about making that perfect when we have proper weather to make the cable fast, so that there will be no chance of its chafing as on this occasion. If there is any question about any of these matters on which you wish me to give you any further information I shall be happy to do so. There is another work we are carrying on, as you are aware—the lighting by electricity of the Paddington Station. That work, I hope, will be ready in about a couple of months. I must confess it has taken longer than we had expected to get ready, but it is the largest work that has been done in England.

The MANAGER: The largest work in the world.

The CHAIRMAN: Well, probably. I know it has been exceedingly well done, and I hope when completed it will be a great success, and will be a sort of pattern card for this Company for making any similar kind of work in other places. As you are aware, we have important Provisional Orders for lighting the parish of St. James's. Well, of course it is a new thing, and we were very anxious to have some experience and knowledge of its cost before we went into so large a matter as the lighting of St. James's parish. We were therefore very glad to have the opportunity of lighting a large station like Paddington, which is all in one control and not subject to a great number of houses, and it will give us that experience which will enable us to judge of our mechanical and economical efficiency to undertake the lighting of large towns. The experience will be very valuable to us, and I think we were very wise in getting it before we embarked further in this scheme. The report mentions that we are building a new ship to replace some that are not so young as they were. That will be ready in the course of the summer. I may mention that the Government have chartered two of our ships, the "Calabria" and the "Kangaroo" for the purpose of going to Suakim to condense water for the troops. They are engaged for three months certain, and so much longer as the Government like to keep them. These ships are fitted with large cable tanks, which enable them to store large bodies of water on board, and such, perhaps, are the only ships afloat that are capable of doing that work efficiently. I do not think there are any matters in the accounts that I need mention, but I shall be glad to do so if there is any question, and I shall also be glad to explain any item. I cannot convey an idea of these accounts, but you have them in your hands, and if there is any item you wish explained, in so far as I can, I shall be glad to do so. I now move the resolution.

A SHAREHOLDER said he would like to know the estimate of the new ship, and out of what funds she would be paid for?

The CHAIRMAN: She will be a vessel of about 1,200 tons, and will be paid for out of the steamship reserve. We have ample funds for that.

The SHAREHOLDER said he wished to know the price.

The CHAIRMAN: I do not know whether that is quite wise. Is it? She is being built by Messrs. Laird, of Birkenhead, and we beat down the price as much as possible.

Mr. WAKEFIELD thought that everything the Chairman had said was very satisfactory. The only question he would like to ask as an old shareholder was what opinion the Directors had formed of the lighting at Paddington—whether it would well answer the purpose of the Company in undertaking it? He knew two or three persons who had lighted large establishments with electric light, and it did not seem to answer at all. It was much more expensive than gas, and not of much advantage. He could understand that in a large place like Paddington Station it was a very great boon, but did the Directors think it would pay the Company?

A SHAREHOLDER asked whether the Company had any good cable orders on hand.

The CHAIRMAN: The quantity of cable work on hand for the current half year is about 1,000 miles. We have half of that completed. As to the question of Mr. Wakefield, I may say that I do not believe the Paddington lighting will pay us, but it will pay us in a form—we shall know exactly what it will cost. I think our engineer somewhat under estimated the cost of the work, but I do not like to deceive you into supposing that it will not cost us something as an experiment. As to its success I have no doubt. We have worked the electric light on the platforms there for three or four years, and I have never had any difficulty in connection with it except for the first few months after starting, when our engine did not work thoroughly well. Since then there has been no difficulty, and that it is a vast advantage to the railway company there is no doubt. The porters can see exactly what they are doing.

A SHAREHOLDER asked whether the result would be such that other companies would take it for their stations.

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The CHAIRMAN: I hope it will answer. A gentleman says he knows several cases where the electric light does not answer, but I know other cases where it does. We must take a view apart from cost as to house lighting. I do not care whether it costs me £5 or £10 more, but I think, having a perfectly pure light, I should save the extra cost twice over by no damage being done to my pictures, decorations, and works of art. Here is where there is one direct advantage from the electric light. I do not think it would affect the question if it were £2 or £3 more, but I believe those who are using it do not find it more costly than gas. In large places the electric light will come out better still in comparison with gas as to cost.

A SHAREHOLDER wished to know if anything had happened during the year to their large steamships. In last year's report it was stated that the ships were in efficient condition, but in the present report it was stated that in view of wear and tear of some of them it had been decided to build a new vessel. He did not quite understond this, unless something had occurred. It was also said that the "Seine" was being supplied with new engines and boilers, and was undergoing a thorough refit. He could not understand the necessity for that in view of what was stated last year as to the condition of the ships; and if anything had happened since he thought the shareholders ought to know it. It was stated that the cost was to come out of some fund which had been provided for the purpose, but he saw no mention of that fund in the balance-sheet. There was an item, "By property, consisting of freehold and leasehold premises, machinery, plant, stocks of stores, materials, leases, &c., £483,973." He and some other shareholders would like to know the value of the freehold premises, and what was the amount they had invested in ships, what was the amount in freehold premises, and so on. They had a large property at North Woolwich which was shut up and, he supposed, unremunerative. He did not think it ought to remain idle. Then in the second paragraph of the report it was stated that they had earned so much net profit, and it was a satisfactory statement that the amount enabled the payment of a dividend of 20 per cent.; but present investors only got about 6½ per cent., which, in his opinion, was nothing very extraordinary for a trading concern, though it was very good. What he wanted to point out, however, was that the shareholders were only informed of the net profits; they knew nothing about the gross profits or the establishment charges, and many other matters which in such an undertaking they were, he considered, entitled to know. He would also like an explanation of the item on the other side of the balance-sheet—the lump sum of £485,000 against the item of debts owing by the Company, and reserves for insurance, debentures, and contingencies, and suspense accounts for unfinished work. They had cash in hand £198,000, and he thought there was no necessity for their having any very large amount of trade debts.

The CHAIRMAN: You are reading from last year's accounts as far as I can understand, though there is not much difference.

The SHAREHOLDER: Yes, they are about the same.

Mr. WILLIAM ABBOTT presumed that the last speaker was a new shareholder. About twenty years ago he (Mr. Abbott) made the same mistake in asking similar questions; but he had grown wiser, and was quite content to take the Chairman's advice and study the accounts. After twenty years' experience he was satisfied, so long as Sir Daniel Gooch presided over the affairs of the Company, assisted by such able colleagues, to accept what was given him with thanksgiving. He had often noticed that the Chairman came before the shareholders in a very meek spirit, indicating no cable work to do, but still the same 20 per cent. dividend came round each year. He would recommend any sceptical shareholder to study the map in that room, when he would see the enormous amount of work they had carried out, and he would not only be satisfied with what the Company had done but would be proud to belong to such a company. He was at the recent meeting of the Anglo-American Telegraph Company, when Lord Monck announced that the only four cables then doing the work of Atlantic telegraphy were the four laid by this Company. They saw from the map the small spot which England occupied upon it, yet she was the pivot upon which the whole trade of the world turned, in consequence of the enterprise in which the Company engaged twenty years ago, and from which the shareholders were now reaping the fruit. He asked no questions on the accounts. The purchase even of a new ship did not seem to be regarded as any very serious matter by the Directors, and no call was made on the shareholders to subscribe for debentures to meet the cost. They might sing, "We've got the ships, we've got the men, and we've got the money, too," for there was no doubt whatever that those important compounds were present in their Company. They had a staff second to none in the United Kingdom; and the wonderful zeal thrown by them and the Board into everything connected with the undertaking, with the enormous power of their cash reserves, enabled them to do what they did for the shareholders.

The CHAIRMAN: As to the question of an honourable proprietor he knows, if he has been long a shareholder in this Company, the reason why we have not set out all those figures and details. It would be absurd in a Company like this to give all the information that partners in a firm of three or four receive. Our affairs are larger, and require a certain amount of reservation. A great many years ago we adopted a form of accounts with that view, and you must put a certain amount of confidence in your Directors. The figures comprising that large item of £485,000 are the value of our premises and other properties. If the honourable shareholder is a man in trade, he must know that that amount is composed of thousands of items—in fact, everything we have to carry on our business with. To put all that information in our report would require volumes, and then you would not understand it. As to the ships, it is quite true that the "Seine" and the other ships were in thorough order twelve months ago; but we could not know then when new boilers would be required. The "Seine" has been sent to Messrs. Laird's to be re-boilered and put in thorough order. You must have some of the ships going occasionally into repair, while others are in an efficient condition. The cost of all that repairing comes out of your business—the revenue, but the cost of the new ship will come out of the reserve. I do not know whether I omitted to answer anything. The Chairman then put the resolution, which was carried unanimously.

The retiring Directors, Sir Geo. Elliot and Mr. Philip Rawson, and the Auditors were next re-elected.

On the motion of Mr. WM. ABBOTT, seconded by Mr. WAKEFIELD, a vote of thanks was passed to the Chairman for presiding, Mr. ABBOTT remarking that the Chairman was always in his place at their meetings, and always voting on the right side in the House of Commons.

The CHAIRMAN: I am very much obliged to you. We try to do our best. I am sure you are all conservatives as to having a good dividend, and that you will not object to that as a conservative measure at any rate.

The proceedings then terminated.

South-Eastern Brush Electric Light and Power Company.

An adjourned general meeting of the shareholders in this Company was held on the 27th February at the offices, Cow Cross-street, E.C., under the presidency of Mr. T. Fry.

The CHAIRMAN: Gentlemen, this is an adjourned meeting for the purpose of receiving the report of the committee appointed at the ordinary general meeting in December last, and you will have to consider to-day and to decide whether you will receive or reject that report. Now, the date of this meeting has been fixed expressly to suit the convenience of members of the committee. Certain dates were given us on which we were told it would not be convenient for them to attend, and we fixed this day. Notwithstanding that, it does seem strange that, not content to wait till an expression of opinion had been given by the shareholders, one of the members of the committee, in conjunction with a shareholder, has obtained signatures to a requisition calling upon the Directors to convene an extraordinary general meeting for the purpose of considering proposals to wind up at once, and to appoint two of their members as liquidators. This is a very nice little family arrangement, and probably may be very agreeable to those who propose it; but we, the Directors, shall have something to say to the shareholders before they appoint as liquidators gentlemen who have taken up such an attitude to the Company that we are suffering at this moment to a very serious extent. We hear that our business at Colchester is stopped from being extended simply from the fact that, owing to the reports which have appeared and the statements made by the committee, our customers will not, we are told, go to the expense of laying on a supply of the electric light because they do not know how long it may be continued [A Voice: Quite right]. It appears to be quite right from your point of view, but from ours we say we are suffering. It is now for you of the committee to give some reasons why your report should be received, and it is for you to propose its reception and adoption.

Mr. REGINALD BRAITHWAITE: I will not waste time by answering the Chairman's speech, though I have a complete answer to all he has said; but I will simply move "That the report of the Committee of Inquiry be adopted by the shareholders."

Mr. COMBERBACH seconded the motion.

Mr. C. H. STEWART: It now becomes my duty to give some reasons for the course pursued by the committee and the report they have issued to the shareholders. I must call you back to the institution of this Company in 1882, and I shall also call your attention to a few of the items contained in your first statement of accounts. I shall also go into the question of the arrangement as between you and the Consolidated Company. I charge the Directors with making a most improvident arrangement. In their report presented here they allude to the arrangement made here in the first place in regard to the experiments carried on by our paid officials, who are paid high salaries for attending to the business of this Company. These are the men who during their term of employment here in this Company were engaged in those experiments. What for? For this Consolidated Company. You invented machinery for this Consolidated Company. As to the commitments of capital, the amount spent in time and also in regard to those experiments and appliances in the office in Victoria-street should have been carefully taken into account, and should have made you very careful in those arrangements with these officials. I never heard of such a thing—and many of the shareholders may be ignorant of it—that in arranging with a company for this affair with 100,000 shares you allot to those men—your own *employés*—60,000 shares in that company, retaining only 20,000, or one-fifth, for this Company and the same for the Provincial Brush Company. I allude to that just by the way, because I think most of the gentlemen here are also shareholders in the Provincial Brush Company. I there charge you with making a most improvident arrangement, and giving the power entirely into your own *employés'* hands. To men whom you ought to have kept a tight hold on you gave control of the Consolidated Company, and, beyond that, you committed this Company to find £10,000 capital towards carrying on the business of that company, and you took debentures, which from what I am advised are of such a nature that you cannot put them in force, as they are dependent on earnings. You have not shown us, the shareholders of the South-Eastern Company, that we have made any profit. You have refused to give us any information as regards the working of this Company. I find in the various items of the account that this Company is bearing all the brunt of the expenses themselves in testing the quality of these batteries which are now at Colchester, with the view of testing the B.T.K. system.

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In addition to the £10,000 you committed this Company to in hard cash, you go beyond that, because you incur an expense of over £7,000 in establishing this lighting at Colchester, which is losing the Company something like over £1,000 a year [The Chairman: No, no.] That is how the account stands as far as I am able to judge. If you take into account the loss on working, and the depreciation of plant, I think you will find it is fully £1,000 of loss. Well, then, is it not time we should put a stop to this extravagance? Can you say it is too soon, when you find in the last statement of accounts—concessions, preliminary expenses, and so on—an item put down at £14,711? What is the value of that asset? The concessions, as regards your arrangement with the Brush Company, I consider in a measure worthless; and I take it that this item of £14,711 is almost worthless. We do not mean to say that we shall not obtain something; but it will be very small indeed. As to the amount paid for provisional orders, I look on that as entirely lost, because no man with the knowledge which I and others here have would ever attempt to light towns on those provisional orders, which would entail even heavier loss than that at Colchester. I think, as to Colchester, that you may take it that a very large amount of the expenditure there is lost. I do not know what the plant would realise if it had to be removed from Colchester. The only chance would be if it could be sold to the Corporation, or to a private company. If, however, you value it at the full amount stated, you have still the loss of more than one-third of your capital [A Voice: Far more]. Then we come to stock and office furniture.

The CHAIRMAN asked of what use it was to go into the items mentioned by Mr. Stewart. The accounts had, he said, been discussed, and the meeting was to consider the report of the committee.

Mr. STEWART: I do not treat these items as assets. They are fictitious. You have no assets except the plant at Colchester, the stock in the office, the debentures of the Consolidated Company, and 20,000 shares. I believe a very large number of those have been sold from 1s. to 3s. each. You therefore see that the greater portion of the capital is lost. In the working of this Company, what do I find? It has been worked most extravagantly. It was said for some time that the Board were most moderate in their fees, but I find they have been about £2,300 during 1883 and 1884, and I heard from the Chairman that they were not going to take fees. I hope if the Company goes into liquidation that they will consider that, and consider that they have had ample, and more than enough, in the two previous years, and will do some little justice to the shareholders by foregoing any further fees. This Company and the Provincial are kept on merely as "milch cows" for providing funds for the Consolidated Company, over which you have not the control. These patents which cost this Company so much, not only in time but also in expenditure—all this is entirely in the interest of the Consolidated Company, because you make over the patents, which we have absolutely made such sacrifices for on account of the Consolidated Company, to the Consolidated Company. You also charge the expense of office lighting to this Company which was necessary, more especially for testing the batteries of the Consolidated Company. Everything is charged to the South Eastern Company—at any rate to a larger extent than the Provincial Company; but both are milch cows for the Consolidated Company. I think I have made out a sufficient case for the immediate winding-up of this Company.

Mr. BLEWITT asked whether the report of Professor Forbes had been received, and if not whether the Directors or officers had had any intimation of what the nature of it would be.

The CHAIRMAN replied that a private and confidential report had been received, which was exceedingly satisfactory to the Directors of the Consolidated Company. That would be forthwith followed by a report which they would be allowed to publish, according to their agreement with Professor Forbes. That report the shareholders would have shortly. For the present he would state that it was very satisfactory.

Mr. BLEWITT: Why is it, if £50 was paid to Professor Forbes to make a report to this Company ——

The CHAIRMAN: Not to this Company.

Mr. BLEWITT: £50 of our money. It is stated so in your own report.

A SHAREHOLDER: I second the winding up.

Admiral Sir E. A. INGLEFIELD, C.B., observed that he was one of the liquidators of the Metropolitan Brush Company. They had been able to collect a great deal of information—not only useful for that company, but for all companies connected with the Brush Company. On that ground he spoke to the subject that the Company be wound up, or that the report of the committee be adopted. It would be for the shareholders' benefit, as in the case of the Metropolitan Brush Company. What remained would be saved, and economy would be practised, if the winding-up the voluntary liquidation were conducted in the same manner as that in connection with the Metropolitan Brush Company. He was satisfied from all he had learnt that nothing was to be made out of the provisional orders. The time might come when the electric light might be useful all over the world, but that time had not yet arrived. He spoke not only from the information he had obtained as a liquidator, but also from the information he obtained as Chairman for two years of the Maxim-Weston Company.

Mr. BLEWITT thought that any report of the committee would be justified by the circular, signed by Mr. Fry, which had been issued for the Directors, and by the speech of the Chairman. The committee saw that there was an afterthought and an intention to let the miserable existence of this Company drag on as far as possible. The only two points which bore Mr. Fry's name were these—first, that the committee were going to destroy the concern and then try to sell it. If, however, they went to the Anglo-American Brush Company they would go with this position: "We want to sell this concern to you. If you do not buy it we shall wind up." [The Chairman: "Just so."] As to the Colchester concession, the Directors held out a faint hope that it was going to be taken over by the Corporation or some private company. In either case, however, he presumed that that would have most likely happened when it had not been proved that the whole thing was a failure. But the Directors had waited until the whole thing had proved to be a failure, and now they held out the suggestion that the Corporation or some private company was going to take it over. How long was this Company to last—until the Directors found out whether the Corporation or a private company were going to buy it? He thought the committee had exercised a wise discretion in deciding to put an end to the Company.

Mr. J. BRAITHWAITE, jun., said he thought it right to say, as one of the Directors of the Anglo-American Brush Company, that the Directors of this Company, by their prudent and far-seeing policy, had made arrangements by which they had given over their concessions to the Anglo-American Brush Company. They had nothing to offer to that Company, and he had authority from the Anglo-American Company to say that they were not prepared to consider any proposal as to offering anything for the assets of this Company. Any suggestion of the Chairman of that sort was, he said, merely an endeavour on the part of the Directors to keep themselves in office a little longer and take a few more fees, till they had completely gutted the Company, and transferred all that remained to the Consolidated Company.

The CHAIRMAN: We are obliged to Mr. Joseph Braithwaite for coming and telling us that the concessions held by this Company from the Anglo-American Company are worth nothing.

Mr. BRAITHWAITE, jun.: I did not say so. I said we have got them, you having parted with your birthright.

The CHAIRMAN said he admired the candour of Mr. Joseph Braithwaite, but how did it assist the committee? The committee had said: "Go to the Brush Company. The Midland Company have made an arrangement with them, and so have the Great Western Co., and therefore go to the Brush Company." Now, however, they were told it was useless to do that; but all this would have to be discussed further. The present meeting would decide nothing on that point, because the Directors must call a meeting for considering a winding-up. Mr. Braithwaite had said that the Directors would wait in order to take more fees; but as they had had nothing for fifteen months, he asked that gentleman to admit that he had made an unfounded charge.

Mr. STEWART desired to make an explanation as to the intimation the committee gave stating that the Anglo-American Brush Company would be prepared to treat with this Company. So, he maintained, they would have been. At that time there were calls that could have been made to the extent of £10 a share, and the Brush Company were prepared to take over the whole matter. This, however, would have been going from Peter to Paul, and the wish of the committee had been to prevent the making of calls.

Mr. BRAITHWAITE, jun., said he was quite ready to withdraw anything he had said in error affecting the question of the Directors' fees, but nothing else. It had seemed strange to him that the Directors, with this meeting pending, had made a call of 2s. 6d.

The CHAIRMAN stated that liabilities had to be met, and the shareholders were told at the meeting on the 22nd December that a call would be made in the early part of this year. He thought they might now vote on the motion for the reception and adoption of the report of the committee; but before taking the votes he wished to state that he would object to any one voting who had not paid the call. He would not take the vote of any one who had not paid the call. After counting the votes, he said: Well, gentlemen, there are only in the room four others than ourselves who are entitled to vote, and therefore I declare the resolution lost.

Mr. BLEWITT demanded a poll.

The CHAIRMAN: You are a shareholder, but you cannot vote, as you have not been two months on the register.

Mr. BLEWITT asked what course the Directors would take, in the event of a poll, with regard to the lost proxies. A whole heap of proxies had been lost in the offices.

The CHAIRMAN: We have a list furnished by you.

Mr. BLEWITT stated that that was not so. He explained at the last meeting that as to a portion he had a list, and as to a portion he had not. If a poll were decided in favour of those who demanded it, well and good, but if decided against them it must be abortive, because of the lost proxies.

A SHAREHOLDER: Who stole the proxies? [laughter.]

The CHAIRMAN said they would admit all the proxies, but only those could be used as to which the call had been paid.

Mr. BLEWITT said that that could not be done, as the Chairman did not know what proxies had been lost.

The CHAIRMAN said that another meeting would be called, probably in ten days, to consider the proposal for winding up, and the matter could then be discussed.

Mr. STEWART wished the press to know that the resolution was lost by the votes of the Directors only.

The CHAIRMAN: No, no. There are others [A Voice: Paid nominees].

Mr. BLEWITT said he would recommend the withdrawal of the poll if the Directors would give an undertaking not to issue anything.

The CHAIRMAN declined; and in further reply to Mr. Blewitt respecting the proxies, stated that circumstances had altered since the general meeting. The Directors had proxies superseding some of the others. Other shareholders had not paid their calls, and some had transferred their shares.

A SHAREHOLDER: You had no right to make a call with this meeting pending.

The CHAIRMAN replied that he knew his duties as chairman, and they had been perfectly in the right to make a call. They were also right in refusing to accept the votes of those who had not paid the call.

A SHAREHOLDER: The call was made in violation of the pledged word of the Directors.

The CHAIRMAN repeated that at the last meeting the shareholders were told that a call would be made in the early part of this year.

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A SHAREHOLDER: Do you object to receive a call for the purpose of a poll?

Admiral INGLEFIELD asked what the Directors proposed to do next?

The CHAIRMAN: To call a meeting to consider the proposal for winding up.

Admiral INGLEFIELD: Do you pledge yourselves to support that, or will you get proxies?

The CHAIRMAN: Why should we pledge ourselves, unless we know what you are going to do?

Mr. BRAITHWAITE, jun.: You have made the call obviously for defeating the voting at this meeting. I contend that this meeting is an adjournment of the one commenced in December, before any call was made; and if we were entitled to vote at the commencement of the meeting we are at the end. Will you pledge yourselves to make no further call before the next meeting?

The CHAIRMAN read from his speech at the last meeting, and stated that the shareholders were told distinctly on that occasion that the Directors would "probably make a call of 2s. 6d. in the early part of the year."

Mr. BLEWITT: The Directors are practically the Directors of the Consolidated Company, or a majority of the Board. What did they do immediately it was suggested that a committee of investigation should be formed? They served a notice, at the instance of the Consolidated Company, on the South Eastern and Provincial Brush Company, calling up the whole balance of the debentures.

The CHAIRMAN: We shall have an ample opportunity of discussing this. Having declared, and advisedly, that the resolution for the adoption of the committee's report has not been carried, was lost, I now must, in order to complete the business, move "That the Directors' report and statement of accounts, presented on the 22nd December last, be and are hereby received and adopted."

A SHAREHOLDER: That proves that we are holding the adjournment of the meeting of the 22nd December.

The CHAIRMAN: I move this at all events.

Mr. WAPSHARE seconded the motion.

Mr. BRAITHWAITE, jun., proposed as an amendment that the consideration of the motion be adjourned until after the next meeting.

This having been seconded,

The CHAIRMAN put the amendment, and declared it lost.

A SHAREHOLDER: The amendment was carried by the show of hands.

The CHAIRMAN: I declare it lost, because you are not entitled to vote.

Mr. BLEWITT: Let me ask you to declare on this resolution that you lost the show of hands.

The CHAIRMAN: I declare it lost. I am not going to recal that.

Mr. BRAITHWAITE, jun.: Will you tell us the votes? We ask you to count the votes.

The CHAIRMAN: I do not count the votes. I have declared for the resolution. I will not count the votes.

Mr. BRAITHWAITE, jun.: The Chairman refuses to count the votes of the meeting.

The CHAIRMAN. Of those who have not paid their calls.

Mr. BLEWITT: Would it not be well to adjourn the poll?

The CHAIRMAN: There is no poll.

Mr. BLEWITT: I demand a poll on both points.

The CHAIRMAN: Have you demanded a poll on anything?

Mr. BLEWITT: I asked you whether, for the purpose of demanding a poll, and for the shareholders to put themselves in order in that respect, you would accept the calls and then allow a poll to be demanded.

The CHAIRMAN: Yes; but it is not our business to receive the money. If calls are paid we will receive the votes; but what is the object?

Mr. BLEWITT: The object is to prevent you, by circular, stating to the shareholders that this resolution of the committee has been rejected, and that the resolution adopting the report and balance-sheet were adopted without your being challenged.

The CHAIRMAN: I pledge myself that we should do nothing of the kind. We should simply tell them that this meeting was mere waste of time.

Admiral INGLEFIELD asked whether it was the desire of the Directors to keep the Company going on, or whether they were with the committee in the desire to see the Company wound up.

The CHAIRMAN stated that the Directors had in their circular told the shareholders what they would do. They represented large holders.

Mr. R. BRAITHWAITE: My interest alone is nearly as much as that of the whole of the Board.

The CHAIRMAN said that the only interest of the Directors was to make the best of the position for the general body of the shareholders.

A SHAREHOLDER: Then why did you not wind up sooner?

The CHAIRMAN: Because we did not wish to do what you are doing—destroy what we possess.

Mr. BLEWITT: Is it the intention of the Directors when the calls are paid to pay over the balance to the Consolidated Company?

The CHAIRMAN: As required.

The proceedings then terminated.

TRAFFIC RECEIPTS FOR FEBRUARY, 1885.

COMPANIES.	Feb., 1885.	Feb., 1884.	Increase.	Decrease.
Cuba Submarine	2,700	3,099	—	399
Direct Spanish Telegraph	1,457	1,588	—	131
Direct United States	—	—	—	—
Eastern Extension	40,114	38,900	1,214	—
Eastern Telegraph	61,784	57,396	4,388	—
Great Northern	20,400	—	—	—
Submarine	—	—	—	—

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. MAR. 4.		BUSINESS DONE WEEK ENDING MAR. 4. Highest.	Lowest.
Anglo-American	29½	30½	30½	—
Do. Preferred	53½	54½	54½	54
Do. Deferred	7½	7¾	7 11-16	7⅛
Brazilian Submarine	11⅝	11¾	11 5-16	11 3-16
Cuba	10¾	11¼	10¾	—
Do. Preference	17,	18	17⅞	17½
Direct Spanish	1¾	2¼	—	—
Do. Preference	10½	11½	—	—
Direct United States Cable	9⅜	9⅞	9⅞	9⅝
Eastern Telegraph	11⅞	12¼	12¼	11¾
Do. 6 per Cent. Preference	13¾	14¼	14	13⅞
Do. 5 per Cent. Debentures, 1899	105,	108	106	—
Eastern Extension	12⅜	13⅛	13 1-16	12⅞
German Union	9½	10	—	—
Globe Telegraph and Trust	6¾	7	7	6 13-16
Do. Preference	12⅞	13	13	12⅞
Great Northern	15,	15½	15⅝	—
Indo-European	32,	33	—	—
Reuter's	7½,	8	—	—
Submarine	180,	190	—	—
West India and Panama	⅝,	¾	—	—
Do. 1st Preference	7½,	7⅞	—	—
Western Brazilian	6⅜,	6⅝	6½	6⅜
Western Union 7 per Cent. 1st Mortgage	120,	125	124	—
Do. 6 per Cent. Sterling Bonds	97,	100	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	½,	⅝	9-16	½
Oriental	⅜,	½	—	—
United Telephone	11½,	11⅞	11¾	11½

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞	—	—
Do. (fully paid)	3,	3½	3½	2⅞
Hammond Light (£3 15s. paid)	⅜,	½	9-16	½
Swan	½,	½	—	—
Maxim-Weston	½,	½	—	—

MISCELLANEOUS.

Telegraph Construction	35½,	36½	36¼	35⅝
India Rubber, Gutta Percha, and Telegraph Works	20,	21	20¾	19¾

A CIVIL and PRACTICAL MECHANICAL ENGINEER, of great experience, is returning again to the East the end of the present month. Has a knowledge of the languages, having resided in the far East for upwards of 20 years. Is now desirous of communicating with firms with a view to act as an AGENT for the construction of Iron Bridges, &c., Gas Works for small towns, and also for the introduction of the Electric Light, Telephones, and Electric Bells, and for general engineering.—Address to Aberleigh Lodge, Trewsbury-road, Sydenham, S.E.

ELECTRICAL ENGINEER is DISENGAGED. Has had considerable experience in Electric Light Installations, Land and Ship, in manufacture of Dynamos, Accumulators, &c.—Address S. J., *The Electrician* Office.

EMPLOYMENT WANTED by an ELECTRICAL ENGINEER, who has had experience in Arc and Incandescent Lighting; is a fair draughtsman, and accustomed to wiring and testing; knowledge of foreign languages. H. E. M., Office of this Paper.

TELEPHONE.—ENGINEERS desirous of TENDERING for the Construction of 7 miles of WIRE, send name and address to J. and W. BEANLAND, Bradford, Yorks.

PATENTS, DESIGNS, AND TRADE MARKS ACT, 1883.

In the matter of Letters Patent granted to Herbert John Haddan, of 67, Strand, in the City of Westminster, for "Improvements in Apparatus for the Generation and Application of Electricity for Lighting, Plating, and other Purposes," a communication to him from abroad by Charles Brush, of Cleveland, Ohio, United States of America, dated the 18th day of May, 1878, No. 2,003,

NOTICE IS HEREBY GIVEN, that The Anglo American Brush Electric Light Corporation, Limited (the assignees of the said Letters Patent), have applied under Sections 18 to 21 of the Patents, &c., Act, 1883, and Rules 48 to 56 of the rules made thereunder, for leave to further amend the Specification of the said Invention. A copy of the said Specification, as proposed to be amended, can be inspected at the Patent Office, and full particulars of the proposed amendment were published in the official *Journal* of the Patent Office, issued on the 24th February, 1885, No. 120, page 532.

Any person or persons intending to oppose the said application must leave particulars in writing of his or their objections to the proposed amendment at the Patent Office, 25, Southampton-buildings, Chancery-lane, London, W.C., within one calendar month from the date thereof.

Dated this 24th day of February, 1885.

H. READER LACK,
Comptroller-General.

MESSRS. OPPERMANN BROS. beg to announce that they have the following MACHINES, &c, FOR SALE, prior to stock taking, at greatly reduced prices:—

1	5	Light Experimental Dynamo		£7
2	12	,,	,,	20 each.
1	25	,,	,,	30
1	34	,,	,,	35
1	50	,,	,,	40
1	100	,, Alternating	,,	70
1	300	,, ,,	,,	150
1	6 Arc	,,	,,	60

Several Arc Machines of from 1 to 4 Arc Lights, some 5, 6, 7, and 8-inch double endless Leather Belting at half price, and sixteen Cabath Accumulators at 35s. each.—172, ST. JOHN STREET, E.C.

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NOTES.

THE LUNDY ISLAND CABLE.—The Lundy Island telegraph cable has been successfully repaired, and is now in operation.

THE NATIONAL TELEPHONE COMPANY.—The Perth Exchange of the above company has now 111 subscribers on its list.

ASSAB BAY.—It is said that the Italian Government intend to connect their settlement on the east coast of Africa by cable with Italy.

THE TELEPHONE IN DENMARK.—The number of subscribers to the telephone at the end of 1884 in Copenhagen was 1,105, as against 516 for the previous year.

THE TELEPHONE IN PARIS.—There have recently been opened in Paris ten new telephone call offices. The number of such offices at present actually open for service is twenty-five.

THE INVENTIONS EXHIBITION.—We understand that the Henley's Telegraph Works Company have also supplied electric light cables for the forthcoming Inventions Exhibition, to the amount of £800.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 28th February are £2,403, as compared with £2,517 in the corresponding period of 1884.

THE GAULARD AND GIBBS SECONDARY GENERATORS.—We are in receipt of a comprehensive theoretical and experimental research, by Professor Galileo Ferraris, upon the Gaulard and Gibbs secondary generators.

THE TELEPHONE IN HOLLAND.—The telephone exchanges in Holland are already numerous, and the system is growing steadily into favour. The Nederlandsche Bell Telephone Maatschappy alone have some 2,400 subscribers on their list.

TELEGRAMS FOR THE WEST INDIES AND BRITISH GUIANA.—The cable between St. Vincent and Grenada is now repaired, and telegraphic communication is therefore restored with all places in the West Indies. The cable, however, between Trinidad and Demerara is still interrupted.

THE VITRITE HOLDERS.—The Vitrite Company have written to inform us that the defects complained of in the new vitrite lamp-holders have been remedied; they are the result, it would appear, of careless manufacture. We forbear to express an opinion pending the arrival of samples of the improved fittings.

ELECTRIC TRAMWAYS IN BERLIN.—It is announced that the managers of the Berlin tramways are about to experiment with a view to the use of electricity as the motive power upon the lines of Tegel, Pankow, and Schœneber. The current will be supplied by Faure-Sellon-Volckmar accumulators, placed within the car.

THE ELECRIC LIGHT AT BREMORE, N.B.—Messrs. Crompton and Co. are about to light the residence of Mr. John Fowler, C.E., at Bremore, N.B., by electricity. It is proposed to utilise water-power for the purpose of driving the dynamo, by means of two large turbines. The number of lamps will probably exceed three hundred.

SWEARING BY TELEPHONE.—A Cincinnati printer, who brought suit to compel a telephone company that had removed his telephone, because he made it a medium for the dissemination of habitual profanity, to replace the instrument, has lost his case, the Court holding that the company had the right to remove the instrument.

ELECTRIC LIGHT ON BELGIAN RAILWAYS.—By decision of the Belgian Minister of Public Works, all principal stations on the Belgian State Railways are henceforth to be lighted electrically, as it has been found that the electric lighting of the Luxemburg Station, Brussels, has led to a considerable reduction of accidents at night.

LONG-DISTANCE TELEPHONY IN BELGIUM.—A valued correspondent writes us from Brussels that, on the 4th inst., the Van Rysselberghe system of telephony was applied to the telegraph line between Brussels and Ghent. The double cornet receiver is used, and messages are transmitted with remarkable clearness when care is taken to articulate distinctly.

SUAKIM-TRINKITAT CABLE.—We understand that the Eastern Company's ss. "Chiltern" left Suez on Thursday for Suakim, carrying cable to lay between Suakim and Trinkitat. The order for laying this cable was received on February 22. The necessary cable for the work was at once taken from the store at Malta, and it is expected that the cable will be completed and at work by March 18.

THE PRINCIPLES OF ELECTRIC LIGHTING.—We have received a pamphlet by Mr. Sydney F. Walker, containing much useful information upon the subject of the construction and arrangement of electric light apparatus. The pamphlet, which embodies a paper read by Mr. Walker before the North of England Institute of Mining and Mechanical Engineers, is well illustrated, and discusses the merits of nearly every known dynamo and lamp.

THE VAN RYSSELBERGHE SYSTEM IN FRANCE.—*La Lumière Electrique* has, according to *L'Etoile Belge*, been misinformed in announcing that the French Government have decided not to adopt the Van Rysselberghe system in France; on the contrary, the Government have expressed their entire satisfaction with the experiments made between Rouen and Le Havre, and have confided to Messrs. Mourlon and Co. the appropriation of the line between Paris and Reims.

ELECTRIC LIGHT ON WAR SHIPS.—Some important experiments in electric lighting have recently been made at Wilhelmshaven. The training ship "Mars" has received an installation, costing about £1,500. The bridge of the vessel is illuminated by two arc lamps of 1,800 candle-power each, and a "searcher" of 20,000 candle-power, while the interior of the vessel is lighted by 300 incandescent lamps of 25 candle-power each. It is scarcely necessary to add that the experimental installation has given great satisfaction.

PROLONGED HOURS OF TELEGRAPH CLERKS.—We have received a letter upon this subject, calling our attention to the unnatural strain upon the eyes, the brain, and the wrists, &c., which is consequent upon the prolonged exertions of a telegraphist. With this and with the question of pay we have nothing whatever to do, and we must decline most emphatically to discuss so complicated and ungrateful a matter. The question is simply one of supply and demand; the views of the *employé* and of the employer are diametrically opposed to each other, and we do not care to endorse either of those views.

THE PROPOSED MONSTER LIGHT IN PARIS.—The proposal of M. Bourdais to erect an electric lighthouse 300 metres high, in Paris, is characteristic of the French nation. Whether that project will ever be carried into effect remains to be seen. M. Bourdais is sanguine; and perhaps as France has given us an International Society of Electricians, she may be able to confer the inestimable blessing of an international lighthouse

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upon suffering humanity. The lantern will, it is said, contain 100 arc lamps of 20,000 carcels—say 140,000 candle-power each—or a total of 2,000,000 carcels. Truly magnificent !

CABLE STORES.—We have from time to time recorded the admirable work done by the Eastern Telegraph Company in laying cables and completing connections in periods of emergency. This they are able to do, because of the complete system for storing spare cable and foresight to keep a movable supply in store to provide in such contingencies as accidents and the exigencies of warfare. Tanks to contain the spare cable have been erected at Gibraltar, Malta, Syra, Odessa, Suez, Perim, and Zanzibar. In all, twenty tanks ; and these in addition to five cable ships, which of necessity carry spare cable.

LONG DISTANCE TELEPHONY.—Recent experiments in long distance telephony have been carried out in the Argentine Republic, the system being that of Van Rysselberghe. After the first few trials in Buenos Ayres itself, conversation was successfully maintained between Buenos Ayres and Belgramo, a distance of 22 kilometres (13·6 miles) ; between Buenos Ayres and La Plata, 70 kilometres (43·4 miles) ; and between Buenos Ayres and Rosario, 1,350 kilometres (837 miles). These experiments, which were coincident with the *fêtes* of the foundation of the Republic of La Plata, have given most excellent results.

ELECTRICAL WORKING OF TRAMWAYS AT BRUSSELS.—Advices from Brussels state that the Compagnie Belge et Hollandaise d'Electricité has at length overcome all obstacles connected with the electrical working of the Rue de la Loi Tramway, Brussels. The Faure accumulators, 48 in number and with 820 kilogrammes, or rather over 16cwt., of lead and oxide, giving out a useful effect of 66 per cent., are charged by dynamos put down for the purpose. The line, about a mile long and with heavy gradients, has hitherto been worked by horses ; but it is found that a saving of 30 per cent. is effected by electrical working.

SKRIVANOW BATTERY.—This battery, contained in two small boxes, 10in. long, 8in. wide, and 6in. high, consists of a number of cells, only an inch in width, in which zinc plates and chloride of silver are placed in certain proportions, with a weak solution of potash as the excitant. It is said to be sufficient for an arc lamp of 600 candles nominal, or for 75 small incandescent lamps. Local authorities contemplating a great expenditure upon gasworks, with all the inconvenience and perpetual annual cost, will do well to pause and consider what is being done elsewhere to provide at far less than the cost of gas a more brilliant and beautiful illuminant.

THE SOCIETE INTERNATIONAL DES ELECTRICIENS.—The first meeting of any importance of this society, which was to have been held in the Observatory in Paris on Sunday next, has been postponed for eight days. The proceedings will be private, visitors being admitted only upon presentation of a card of invitation in the names of Admiral Mouchez and the President of the Society. These may be had upon application to the members. There will be one or two conferences of electricians in a special apartment each evening. Other rooms for exhibits will be open daily from 1 p.m. until 5 p.m., and from 8 p.m. until 11 p.m.

THE ANTWERP EXHIBITION.—The exhibition works at Antwerp are being rapidly pushed forward, and the exhibitors have already commenced to arrange their stalls. The machinery section is notably in a very advanced state. The firms of Carels, Bollinckx, de Kerkhove and Cail, have nearly finished the foundations destined to receive the engines which they propose to exhibit. The municipal authorities of Antwerp are now making arrangements for a new line of tramways, between the L'Est Station and the exhibition buildings, upon which it is proposed to experiment with different systems of traction, steam and electric motors, &c.

THE TELEPHONE IN BELGIUM.—On the 8th of April next the public adjudication of the concession for the establishment and exploitation of a telephone exchange system in the town of Namur and the neighbouring communes will take place at the Bourse de Commerce of Brussels. The new exchange will be connected telephonically with the other towns in Belgium. The notice of adjudication contains the clause that the subscribers shall be enabled to transmit their messages over a distance of 200 kilometres (124 miles), by means of the aerial lines, and upon the Van Rysselberghe system, so that telegraphic and telephonic communications may be simultaneously exchanged.

A NEW PHOTOMETER.—A description of a new photometer has recently been laid before the Société Belge D'Electriciens by M. Wybauw. The white light of the electric arc lamps has hitherto presented great difficulties in the calculation of the candle-power of such lights. The photometers commonly used give erroneous results, in that the arc lamps of 5,000, 10,000, and 20,000 candle-power, according to the manufacturers' value, are not seldom found to be considerably below those figures. By the method of M. Wybauw the difficulties presented by the difference of flame and arc colour are surmounted, and by a calculation of a somewhat complicated nature the measurement may be made with mathematical exactitude.

THE ELECTRIC LIGHT IN THE SOUDAN.—We are informed that a number of sets of arc light apparatus have been ordered, of Siemens, Brush, and other manufacturers, by the Government, for immediate despatch to Suakin. It is proposed to use Brotherhood engines to supply the power required for driving the dynamos. We should suggest that fixed engines, requiring a bed plate, a suitable position where fuel is abundant, and being difficult of transport, are not likely to conduce to the perfect success of the projected installations. Traction engines would, in our opinion, be found of more practical value ; they could be utilised for the purposes of transporting fuel and water, and could be moved to any desired spot with less difficulty than the others.

ACADEMIE DES SCIENCES' COMPETITIVE PRIZES.—The prize which was granted in 1884 by the mathematical section of the Académie des Sciences for the best essay upon "Perfection in each Important Point of the Theory of the Application of Electricity to the Transmission of Work" has been further extended to the year 1886, the subject being the same. The prize consists of a medal, value £120. The essay for 1885, to which an equal reward is attached, is to be upon "The Origin of Atmospheric Electricity, and the Causes of the Development of the Electrical Phenomena in Storm Clouds." Competitive papers will be received up to the 1st of June, 1885, and must be accompanied by a sealed paper containing the name and address of the author ; this will not be opened until the prize has been adjudged.

A UNIVERSAL AGENT.—The *Western Morning News* says:—"There seems to be no end to the uses to which electricity is being applied. In commercial enterprise as well as in other directions it is now largely used, and one of the latest instances of this may be seen at the Army and Navy Hotel, in Victoria-street, Westminster. Here it is used to summon

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the servants, illuminate the building, book seats at the theatres, call cabs, give notice of fire, communicate with places of business in the City, and convey the news of the day from every part of the world. In this as in other respects those who are responsible for the management of 'the Army and Navy' have kept well abreast of the times, and everything is done to secure the comfort and convenience of visitors, whether singly or in families."

THE ELECTRIC LIGHT AT THE MUSEE GREVIN.—The *Bulletin International des Téléphones* says:—The application of the electric light to the illumination of the Musée Grévin is perhaps one of the installations which has most satisfactorily demonstrated its superiority in a decorative sense, while the facility with which it lends itself to lighting purposes of all kinds leaves nothing to be desired. The installation comprises 372 Edison incandescent lamps of 8 and 16 candle-power; giving altogether a total intensity of 4,336 candles, and two arc lamps of the system Cance. The current is supplied by an Edison dynamo A, for 300 lamps, driven by an engine of 50 horse-power, supplied by Lecouteux and Garnier; the boiler being an inexplosible generator of the Collet system. The lamps are divided into 10 circuits, which are again subdivided in accordance with the requirements of the building. The two arcs are placed at the entrance to the museum.

JOINTS FOR INSULATED WIRES.—It has been stated that "bound joints" have cost a contractor a very large sum of money to replace by well-soldered joints. Joints should not be soldered with "killed salts," but with resin, for if killed salts are used the whole of the joints will, to a certainty, give way by being eaten through in a short time. The perfect success in submarine cable jointing has been only arrived at by a constant supervision over the jointer's work by the electrician, and by every joint in the factory being duly and severely tested, and a record kept of its condition and position. In the same way workmen can only be trained to make electric light joints thoroughly, by the electrician in charge seeing to, and even testing every joint, until he can place implicit confidence in the jointer; in fact, electric light joints have to be better made, if such is possible, as far as metallic contact is concerned. There is no difficulty in soldering a wire capable of carrying 100 amperes or more if done in the proper way.

ELECTRICITY FOR WORKING RAILWAY SIGNALS AND POINTS.—In our leader of last week upon the subject of Mr. Timmis's paper we expressed a desire to hear what conclusion the railway people had arrived at with regard to the experiments recently carried out at Swansea, as one or two electrical engineers connected with railway signalling were dubious about the safety of the system. Mr. Timmis, however, has favoured us with a letter in which he states that the Swansea signal, which has just had a mile of tell-tales and bells, &c., added to it, was merely put up by him commercially; was, in fact, "ordered," "put up," "invoiced," and "paid for." We are pleased to be able to add that Sir Samuel Canning has reported favourably upon the comparative cost of the Currie-Timmis system as against that of the present mechanical system, and sees no reason whatever to differ from Mr. Slater, the manager of the Gloucester Waggon Company, and Messrs. Capper and Schenk, the superintendent and engineer of the Swansea Harbour Trust, as to their high estimate of its efficiency.

VERY LONG DISTANCE TELEPHONY.—We are glad to find that our contemporary, *L'Electricien*, supports us in the view we took of the alleged proposal to experiment with the object of establishing telephonic communication between Brussels and Madrid. Our contemporary says:—Many journals have announced that the Belgian Government were about to enter into negotiations with the French and Spanish Governments in order to obtain the necessary authority to experiment between Brussels and Madrid with a new microphone invented by an officer of the Belgian cavalry. The result of the inquiry we have made has been to show that the report is utterly without foundation; but if it were not so, would it not be demanding of the microphone in question just a *little* more than it could reasonably be expected to perform? Together with the Blake, Berliner, Ader, and other transmitters, it may be adapted to long distance transmission, but *è muito longe de China a Peru*, and, telephonically speaking, so it is from Brussels to Madrid. Unless special lines and special wires are to be constructed, it is difficult to imagine how, with the most perfect of instruments, such a result could be obtained.

SOME APPLICATIONS OF ELECTRICITY.—*The Detection of Heat:* It is often necessary, in scientific investigations and in meteorological observation, as well as in other practical departments, to be able to detect very minute traces or small variations of heat. The thermopile is, as far as we know, the most valuable and practical method, and will detect the heat of a star; but it would not be able to detect the heat developed in a telephone receiving diaphragm, the heat being produced by the mechanical vibrations of the said diaphragm against the opposing electrode; nor would it detect the heat produced in a large wire by the passage of a current from one pair of a thermopile; nor would it detect the heat produced by compression of a piece of metal by another piece of the same weight; nor would it detect the heat or cold of an approaching object with any degree of sensitiveness, the said object being, for instance, a vessel at sea or an iceberg.—*Wanted, an Electric Gas Meter:* Supposing that gas will still be used by sceptics in electric lighting, and that the gas meter will continue to exhibit one's latent faculty for lying, it would not be a useless task to get up a genuine electric gas meter, and then it might be discovered that it could also be employed by electric companies as a gas electric meter. Water gas meters are objectionable, and mechanical gas meters are more so, while an electrical gas meter might be most so; however, its efficiency cannot be predetermined.—*Electrical World.*

THE ELECTRIC LIGHT IN GREENOCK.—An official inspection of the new system of electric lighting which has been introduced by the Police Board of Greenock was made recently in the Water Trust premises at Prospect Hill. The chairman of the Electric Lighting Committee and Corporation officials were present. Professor Jamieson, of the College of Science and Arts, Glasgow, the consulting electrician for the borough, also took part in the inspection. About twenty of the outside lamps were lit, as well as a number of the pilot lamps at the machine room. After thanking the gentlemen for their attendance, the chairman said they would perhaps think the work had taken a long time, but they would agree with him it had come to a successful termination. That success they owed almost entirely to their contractor, Mr. Beckingsale, who had spared neither time nor labour in the work. He had had the advice and assistance of Professor Jamieson, of Glasgow, and their own engineers, Mr. Stewart and Mr. Wilson. Now that the system was started he hoped that the whole community would see that they had done a good work. At all events it showed what could be done in the way of electric lighting. Mr. Beckingsale, in acknowledging the compliment, said that their operations had been greatly retarded during the last three months by the heavy rainfall. Professor Jamieson enumerated the difficulties which had to be overcome

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in connection with the insulation of cables, and remarked that he would watch the outcome of these operations with interest.

KNOWLEDGE IS POWER.—Some curious tales have been told of telegraphic blunders, and some amusing instances have been quoted of the peculiar ideas entertained by non-technical people as to the nature and capabilities of electricity and electrical apparatus. It is scarcely fair, perhaps, for us to tell tales out of school, but the following anecdotes, as illustrating some of the abstruse speculations into which it is possible for the human mind to enter, are too good to be withheld:—Some time ago at the ——— station of one of the cable companies, an operator who had charge of a Morse circuit, found that something had gone wrong; what, he knew not, but something. He examined the relay; coils still there! The instrument; nothing perceptible! Ink; *that* was all right. Despair! Ha! the batteries. Some hours afterwards the following note was to be seen on the office diary:—"Signals failing; on examining batteries found nearly all the zincs EATEN AWAY BY THE POTS!" The cells were Daniell's with earthenware outer jars. At another station we heard of an individual whose intelligence was almost equally brilliant. There was, it appears, a partial fault in one of the cables, and from time to time the condensers were short-circuited and a powerful copper current put to line for a few moments to seal the fault. X noticed this being done, and his able mind grasped the details in an instant. During the night he short-circuited the condensers, but magnanimously forbore to worry the cable by administering the electrical dose of copper. That being so, it was unreasonable in him to officially criticise the action of the "copper-box" so unkindly. Both these men had been engaged in telegraphy for ten years or so.

ANCIENT TELEPHONY AND PHONOGRAPHY.—The following communication was recently made to a meeting of the Royal Asiatic Society in Shanghai:—"It detracts nothing from the merit of the ingenious physicists who have conferred on mankind the boon of the telephone that its principles are familiar to uncivilized peoples, several of whom are in possession of rudimentary telephones. It was, I opine, when the Chinese were in their youth that they constructed the rudimentary instrument a specimen of which I herewith transmit for the society's museum. It consists of two bamboo cylinders, one and a half to two inches in diameter, and four in length; one end of each is closed by a tympanum of pig bladder, which is perforated for the transmitting string, the string kept in place by being knotted. This rude instrument is styled the 'listening tubes,' and is employed for amusement as a toy, conveying whispers forty or fifty feet. It is unknown in many parts of the empire, Chih-kiang and Kiangsu being the only provinces (so far as I can ascertain) where the listening tube is employed. Besides this toy, Chinese ingenuity produced about a century and a half ago the 'thousand mile speaker.' The implement is described as 'a roll of copper, likened to a fife, containing an artful device; whispered into and immediately closed, the confined message, however long, may be conveyed to any distance; and thus in a battle secret instructions may be conveniently communicated. It is a contrivance of extraordinary merit.' The inventor of the 'thousand mile speaker,' Chiang Shun-hsin, of Huichou, flourished during the reign of Kang-hsi, 17th century. He wrote on occult science, astronomy, &c. The above account of his invention was taken from his works by the author of a Fuhkien Miscellany. At that time—reign of Kien Lung—there was no longer an instrument of this description in that province. It seems to have perished with the ingenious scientist who contrived it."

THE VOLUNTEER TELEGRAPH CORPS.—On the 9th inst. a detachment of fifteen trained telegraphists of the Royal Engineers' Reserve of the Post Office Volunteer Regiment, who are under orders for the Soudan, was paraded at the General Post Office and addressed by the Postmaster-General. Lieutenant-Colonel Taylor; Mr. Algernon Turnor, financial secretary to the Post Office; Mr. C. H. B. Patey; Mr. F. E. Baines, inspector-general of mails; Mr. T. Jeffery, controller circulation department; Mr. H. C. Fischer, controller Central Telegraph Station; and others were with the Postmaster-General. Addressing the men, the Postmaster-General said he was very glad to be able to see them prior to their departure for Suakin, for the purpose of bidding them farewell. Their comrades, who had already gone out to join Lord Wolseley's corps, had behaved themselves in an honourable, a gallant, and an admirable manner, and he trusted that they would do the same in the future. They would be attached to the Royal Engineer Corps, and posted between Suakin and the advanced posts of the Army. He concluded by expressing the hope that they would all enjoy good health and spirits, and return in safety. Lieutenant-Colonel Taylor, on behalf of the detachment, thanked the Postmaster-General. He felt quite certain that the men would do their duty thoroughly well, and he thought he might say that in the Royal Engineers they would have no equals as regards efficiency in telegraphing. He believed that there was hardly a telegraphist left in this country belonging to the Royal Engineers, and without this organisation, which had been encouraged by the Postmaster-General, there would have been grave difficulties in providing for the requirements of the present campaign. He was glad to say that the War Office had sanctioned the extension of the force to 100 men, and that number would, with the necessary permission, be enrolled. The Postmaster-General then addressed the men on the subject of the great heat in the Soudan and the precautions to be adopted against it, and after he had conversed individually with the men the proceedings terminated. Later in the day the detachment left for Aldershot to join the Engineers preparatory to embarkation.

ELECTRIC LIGHTING FOR STEAMSHIPS.—The paper read by Mr. Andrew Jamieson, A.M.I.C.E., &c., before the members of the Institution of Civil Engineers, and of which a digest was given in our issue of 15th November, 1884, has just been published in separate form by the institution. The discussion and correspondence were both of a very interesting nature, Messrs. Farquharson, Allbright, Crompton, and others, affording some valuable items of information as to comparative cost of different systems of lighting and other practical details. Mr. Farquharson said there were but three fighting ships lighted electrically in England. The first lighted by the incandescent system was the Brazilian ironclad "Riachuelo," and since then two other ships in the navy had been fitted, the "Polyphemus," and the "Colossus." A great many transports and troopships had been lighted, and he was able to give some particulars of the results obtained in one or two of them. During the last year and a half five large Indian troopships, the "Malabar," "Crocodile," "Serapis," "Jumna," and "Euphrates," had been lighted, and the Imperial troopship "Orontes." The five large troopships had an installation of about 400 lamps each, and he had some particulars of the cost of two of them, which had been carefully prepared with a view of showing how the cost compared with that of ordinary lighting. Before reading the statement, he might remind the members that it ought not to be assumed that the cost of lighting ships in the Royal Navy by the ordinary system was fairly comparable with the cost of

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lighting other ships. No mineral oil, for example, was allowed in ships of the Royal Navy, and the colza and olive oil used in them was more costly, so that the comparison would not be the same as that with private ships. The details of the cost of lighting Her Majesty's Indian troopship "Crocodile," for ninety days, by the old and new systems, viz., candles and oil, and electricity by incandescent lamps, was as follows: The number of lamps by each system was about the same. The actual number of incandescent lamps was 438. They were of two sizes—viz., 10 candle-power 307, and 16 candle-power 131. It would seem by the details of cost that the bulk of the ordinary lamps were candles, and the proportion of light would therefore be electrically greater as 10 to 1 or thereabout. Details of expenditure with the new system. Incandescent lamps:—Coal, 112½ tons, at 15s. per ton, £84 17s. 6d.; cotton waste, 90lb., at 27s. per cwt., £1 1s. 8d.; oil (mineral), 180 gallons, at 1s. 2d. per gallon, £10 10s.; oil (olive), 23 gallons, at 3s. per gallon, £3 9s.; lamps replaced, 35 at 3s. 6d. each, £6 2s. 6d.; lamp globes, 15 at 3s. each, £2 5s.; fusible wire plugs, at ¼d., 1s. 8d.; depreciation on plant, at 2½ per cent., £12; total, £119 17s. 4d. By the old system, candles and oil:—Candles (stearine), 250lb. at 32s. 4d. per 50lb., £8 1s. 8d.; candles (police lamps), 1,300lb. at 32s. 4d. per 50lb., £42 0s. 8d.; candles (fighting lamps), 1,750lb. at 34s. per 50lb., £59 10s.; candles (signal), 1,430lb. at 34s. per 50lb., £48 12s.; oil, colza, 493 gallons at 2s. 3d. per gallon, £55 9s. 3d.; wicks, cotton, 160 at 1½d. per dozen, 1s. 10½d.; cotton balls, 8lb. at 8½d. each, 5s. 8d.; chimneys, 4s.; depreciation of plant, at 2½d. per cent., £3 14s.; total, £217 19s. 1½d.; less value of cases returned, £4 14s.; =£213 5s. 1½d.; total cost of new system, £119 17s. 4d.; difference in favour of electricity, £93 7s. 9½d; or £377 per annum. The labour on the two systems was practically the same. The statement took no account of labour by the old or by the new system, the fact being that no additional labour was allowed. Two engine room officers were told off to attend to the dynamos and the incandescent lamps, and since as many lamp-trimmers would be employed on the old system the cost for labour would be approximately the same.

Insulation of Electric Light Leads.—Mr. Sydney F. Walker writes as follows upon the important subject of the effective insulation of electric light leads:—Defective insulation that would be of no consequence with an electromotive force of 50 volts may become a serious matter with 2,000 volts. The minimum insulation resistance allowed on ordinary telegraph wires, consisting of naked iron wire secured to insulators, carried on poles, is 100,000 ohms per mile—that is to say, the resistance of the 20 to 25 branch circuits to earth formed by the insulators, brackets, and poles combined, must not be less than 100,000 ohms in a mile; in half a mile it would be 200,000 ohms; in five miles, 20,000; and in 10 miles, 10,000. Now, with an electromotive force of 50 volts, with lamps run in series, the lowest of these figures means a loss of only $\frac{1}{2000}$ ampere on the way, which would be inappreciable; that is to say, the current arriving at the farthest lamp would be weaker than that setting out from the generator by $\frac{1}{2000}$ ampere, and the work done by this current would be represented by

$$W = E\,C = 50 \times \tfrac{1}{2000} = \tfrac{1}{4} \text{ watt.}$$

With 2,000 volts the case is a little more serious. $\frac{2,000}{10,000} = \frac{1}{5}$ A.

$$\tfrac{1}{5}\text{ A} \times 2{,}000 \text{ v.} = 400 \text{ watts} = \tfrac{1}{2} \text{ h.-p. about.}$$

But suppose the wires have been badly put up, or allowed by neglect to lose their proper insulation, either by having the insulators broken by stone-throwing or the wires improperly fixed to the poles by staples; or led over iron roofs, girders, or otherwise badly laid in any of the numerous ways ignorance can suggest so easily, the resistance might even in a comparatively short time fall to 1,000 ohms.

$$C = \frac{E}{R} = \frac{2{,}000}{1{,}000} = 2 \text{ amperes.}$$

$W = E \times C = 2 \times 2{,}000 = 4{,}000$ watts, representing about 5½ horse-power absolutely wasted, and forming a source of danger. The fires that occurred in the early days of practical electric lighting, which the writer believes were principally, if not entirely, in America, were due to two causes—the use of high tension currents, and neglect of insulation. Wires, between which very great difference of tension existed, were stapled side by side on the same board; sometimes the board got saturated with water or oil, and gradually became a sufficiently good conductor to admit the passage of a small current between the two wires. Carbon was immediately deposited, increasing the conductivity, and at last so much current passed, at some particular spot, that great heat was generated and the wood was ignited. In other cases naked wires with high tension currents in them, were left near together with inflammable substances between, a sudden change in the electrical condition of the circuit gave rise to an *extra* current, which, taking the form of a spark, ignited the inflammable substance between the wires. These are, of course, extreme cases, but they will serve to illustrate both the dangers of electric lighting and the perfect safety of electric lighting currents when proper arrangements are made. The wires on dynamos and the electro-magnets of lamps are simply covered with two coatings of cotton, the great object being to get as much wire as possible into the available space, and each layer close together. It follows, of course, that currents of greater strength than the wires are calculated to carry, char and burn up the cotton covering, rendering the machine or lamp for the time being useless. It will be explained later how this may occur, and how it may be avoided. For leads from dynamos to lamps and back again, naked wires may be used quite safely, supported on ordinary telegraph insulators fixed in the usual way, provided it can be ensured that there shall be no danger of two wires, or two portions of the same wire, coming into contact with each other. Should such an accident occur during the time currents were passing through either of the wires, it would probably result in serious damage to them, and possibly to the machine, if the contact removed much resistance from the circuit. Sparks would pass, burning the wires, and if the electrical conditions of the circuit were sufficiently altered they might be completely fused, unless the engine was stopped in time. It comes, of course, to the same thing, if another conductor, such as a piece of copper wire, be thrown across the two wires. In towns, the writer is very strongly of opinion that no naked wires for electric lighting should be allowed, except in very exceptional cases. Should an electric light wire, in which a current was passing, get into contact with a telephone wire, it might cause a fire in the building where the telephone apparatus was fixed, should some sudden change, as a break in the electric light circuit, take place. Wires covered simply with a plait of cotton or jute have been used, but these are not safe for street work. With low tension currents all would be well so long as the cotton was in the same perfect state as when delivered by the manufacturer; but the cases in which this could be depended on would be rather the exception than the rule. Wet, oil, even a change of temperature might create a condition of things favourable to the passage of a spark between wires lying together, which risk would be, when the tension is high, intensified very much.

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XXVI.

The writer of these articles had the misfortune to lose a quantity of manuscript in the autumn of 1883, which contained, among other things, one or two completed articles and much preliminary work into some points of theory not yet elaborated. Recently this has been unexpectedly recovered, and there is therefore no reason why the series should not be completed, although a good deal has happened since the last article appeared on September 29, 1883. Everything hitherto said remains as valid as it was before, and the simplest plan will be to proceed as if no break had occurred.

We can now pass on to consider what happens in a Siemens armature rotating in a uniform field, and making n revolutions per second. Let it consist of $2c$ coils, each of K turns of wire, wound on the drum in pairs—the angle between successive pairs being β or $\frac{\pi}{c}$, just as we considered it in Art. XX. (Nov. 25, 1882); the diagrams of the winding being in Art. XIX.

Let R be the resistance of the armature measured from one segment of the commutator to a diametrically opposite one, or "from brush to brush;" and let L be the self-induction of the armature measured in the same fashion. We will not presume to calculate L, because every coil affects every other as well as itself, and so it is rather complicated; and inasmuch as the drum in practice always contains iron it is not worth while to attempt it; but we will suppose it determined experimentally.

A current entering the armature at one segment and flowing away at a precisely opposite one, will pass through every coil on the armature—c in series and 2 abreast— so that the total resistance is $\frac{c}{2}$ times that of each coil. The current will flow round the constituents of each pair of coils in the same direction; and in fact each pair is virtually but one coil, for, as the amature revolves, reversal takes place simultaneously in both constituents of each pair, as will be seen by referring to the diagram in Art. XIX., two of which it may be useful to reproduce here :—

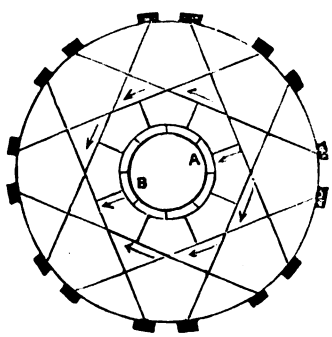

Fig. 10.

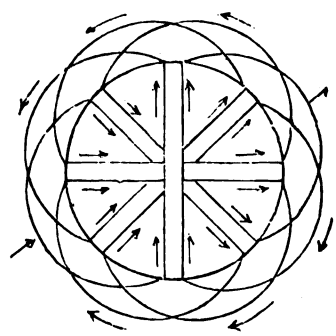

Fig. 11.

They represent the same thing, and taken together they should be intelligible. The outer scallops in Fig. 11 may be treated as the segments of the commutator, and it is then the clearer figure. A B is intended for the line of brushes; and at right angles to this in the diagram is the plane of reversals. Where this plane is with reference to the line of brushes in an actual machine depends on how the commutator is set on the axle, and it is quite arbitrary.

As each pair of coils passes the plane at right angles to A B, during the rotation of the armature, its currents are reversed; hence this is the neutral plane which must be set normal to the lines of force, or rather an angle ϕ in the direction of rotation ahead of this. For observe, that as each pair passes this plane, and has its currents reversed, both constituents are momentarily short circuited, by reason of the two brushes touching adjacent segments of the commutator.

But there are certain curious differences between the present complex machine and the single coil machine or earth inductor discussed in Art. XXV., and these differences must be clearly grasped. In the single coil machine the current taken off by the brushes vanishes twice in a revolution; and accordingly it is possible wholly to avoid sparks by setting the brushes so that the break and reversal may occur at this vanishing position every time. In the multiple coil machine there is no vanishing point at all, the current taken off by the brushes aims at being steady; for only one coil is subjected to short circuiting and reversal at a time—the others are in full work. To wholly interrupt such a current as this, therefore, would entail violent sparking; and, accordingly, it is never to be supposed that the gaps in the commutator are anything like so broad as the brush contacts. To prevent any possibility of a complete break in the circuit it is absolutely necessary that the brush contact shall be broad enough to reach well across from one segment of the commutator to the next; and thus a short circuiting of each coil as its segment passes a brush is ensured, whether it be desirable or not.

But though the main circuit is never broken, it is not possible to set the brushes so that no interruption of current shall occur; for every pair of coils is conveying the whole current, and at the instant when a pair comes up to the plane of reversals, the current *in this coil* is either suddenly reversed or else it is short circuited long enough to allow it nearly to die away, and then the same current is started again, but in the opposite direction. The effect of this process on the main current (*i.e.*, the current in the rest of the circuit) is not very great; it corresponds to a diminution of resistance at the instant when the short circuiting of a pair of coils begins; and an equal gain of resistance, *combined with an increase of self-induction also*, at the instant when the short circuit is over and the coil again enters the main circuit. Sparks at the commutator are therefore, in a multiple coil machine, inevitable, and the only plan is to keep them at a minimum.

The energy lost, as each pair of coils passes the plane of reversal, can be easily expressed. If l represent their self-induction, their current possesses energy, before short circuiting, equal to $\frac{1}{2} l \gamma^2$, and, this having to be destroyed and re-created, the whole loss of energy per pair of coils reversed is $l \gamma^2$; which operation being repeated $2c$ times in a revolution gives a total loss of power equal to $2 n c l \gamma^2$ watts. Half of this loss may go to generate heat in the armature coils over and above the regular heating $\rho \gamma^2$; the other half is necessarily so much energy lost to the main current. The first half may therefore be treated as the heating effect of a sort of spurious extra resistance equal to $n c l$, the second half as a back E.M.F. equal to $n c l \gamma$, which is just the opposing force of the same spurious resistance.

The quantity $c l$ cannot be very different from L, the self-induction of the whole armature, and the coefficient $n c l$ may therefore be written simply n L.

The internal resistance of the armature is not really increased from ρ, its real value, by the motion; because the short circuiting of some of its coils rather lessens than increases its total resistance; but it gets rather more heated than its mere resistance would lead one to expect, the power expended in heating it being $(\rho + n \mathrm{L}) \gamma^2$ watts.

And remember also that at the same time as this extra heat is generated the current is opposed by a back E.M.F., $n \mathrm{L} \gamma$, due to the energy required to re-start the current, and that this is exactly what would be caused by an extra resistance n L; hence, the resultant effect of the successive reversals of the coils is, after all, just to virtually increase the resistance of the rotating armature by this amount n L.

This rather curious result seems to have been originally guessed at by M. Cabanellas; it has been clearly pointed out for the case of a Gramme by Ayrton and Perry, and we believe also by M. Joubert. A rough experimental verification is given by Professors Ayrton and Perry in *The Electrician*, August 18, 1883.

We will obtain the same result in a more general, and perhaps really simpler and more satisfactory, manner before

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long. Meanwhile here are the numbers given by Ayrton and Perry in their tract on electro-motors (*Journal*, Society Telegraph Engineers, No. 49, Vol. XII., 1883).

	Ohms.
Resistance of Gramme ring, at rest	1,768
,, when turning 10 times a second...	1,828
,, ,, 20 times a second...	1,923
,, ,, 30 times a second...	2,045

The increase in apparent resistance due to the motion is thus not very formidable in amount, but quite distinct.

Taking a measure of the resistance of an armature first still, and then revolving at a known speed in a field of no force, or with its axle along the line of magnetic dip, is the easiest method of arriving experimentally at the value of the self-induction L. The above numbers give, for the particular Gramme ring employed, a mean value of about L = 8 ohm-seconds.

ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 307.)

Impressed Magnetic Force. Intrinsic Magnetisation.

The energy definition of impressed electric force, due originally, if not explicitly, at least substantially, to Sir W. Thomson, has long been well recognised by most writers on electrical subjects, especially since the practical introduction of dynamo machines, accumulators, &c., which raised the energy transformations concerned in electrical phenomena from being matters of almost purely scientific interest to matters of the extremest practical commercial importance.

But in our last we gave an energy definition of impressed magnetic force, precisely similar to that of impressed electric force. Thus, if h be the impressed magnetic force at a point, and G the magnetic current there, the rate of working is hG per unit volume, and this amount of energy is taken in per second by the electromagnetic system at the place, and is employed in increasing the energy of electric displacement and the magnetic energy, or wasted in the heat of conduction currents. Also it may be used in effecting bodily motions when there is yielding to the mechanical forces, or in chemical work, &c. Should there be no impressed force, electric or magnetic, except an impressed force h in a single unit volume, we have

$$h\mathrm{G} = \Sigma(\mathrm{Q} + \dot{\mathrm{U}} + \dot{\mathrm{T}}),$$

the summation extending through all space where Q is the dissipativity, U the energy of displacement, and T the magnetic energy, all per unit volume. In order to identify the quantity thus defined, and show the relation it bears to the quantity termed intensity of magnetisation, let there be no electric force in the field, and its state be steady. The second equation of induction (23), goes out, since G = 0, and the first (22) is reduced to

$$\mathrm{curl}\,(\mathrm{H} - h) = 0 \quad . \quad . \quad . \quad . \quad . \quad (33)$$

Integrating once, we have

$$\mathrm{H} = h + \mathrm{F}, \text{ where } \mathrm{curl F} = 0, \text{ or, } \mathrm{F} = -\nabla\Omega \quad . \quad (34)$$

Thus the actual magnetic force H differs from the impressed force h by a polar force F, a force which when analysed is found to be made up by the superposition of radial forces proceeding from points. Ω is the potential, a scalar, variable from point to point.

But, so far, there is nothing to settle what particular distribution of polar force F must be. A second condition is wanted. Now we know from equation (23) that the magnetic current, like the electric current, is always in closed tubes, *i.e.*,

$$\mathrm{div.G} = 0, \text{ therefore } \mathrm{div.}\dot{\mathrm{B}} = 0, \quad . \quad . \quad . \quad (35)$$

and if we take the time-integral we find

$$\mathrm{div.B} = f(x,y,z),$$

any scalar function of position, independent of the time. If, then, the magnetic induction B were not also completely solenoidal, its divergence would continue unaltered at any place, however the field might otherwise vary. It could only be altered by convection, shifting the arrangement of matter. It would then, by a suitable arrangement of matter, be possible to have a unipolar magnet, a quantity of matter round which the magnetic force was everywhere directed outward, or everywhere inward. This being contradicted by universal experience, we must conclude that

$$\mathrm{div.B} = 0, \quad \text{as well as} \quad \mathrm{div.G} = 0. \quad . \quad . \quad (36)$$

The second equation of induction (23), if we use the full expression for G there given, is too general, requiring the limitation $g = 0$, from the absence of magnetic conductivity. The now added limitation div.B = 0, as it does not contradict the second equation of induction, must be considered as an auxiliary condition. Though not necessarily dependent upon the first limitation $g = 0$, it is yet intimately connected with it.

Our two equations are therefore (33) and (36), or,

$$\mathrm{curl}\,(\mathrm{H} - h) = 0, \quad \text{and} \quad \mathrm{div.}\mu\mathrm{H} = 0, \quad . \quad . \quad (37)$$

and the question is, given μ the permeability, and h the impressed force, find H the real force. Using (34) we have

$$\mathrm{div.}\,\mu(h + \mathrm{F}) = 0, \quad \mathrm{curl F} = 0, \quad . \quad . \quad . \quad . \quad (38)$$

and, with the same data, we have to find F. By the second of (38), F is restricted to be a polar force; by the first it is still further restricted to have, when multiplied by μ, a given amount of divergence, thus, $\mathrm{div.}\mu\mathrm{F} = -\mathrm{div.}\mu h$. The two conditions together make F perfectly definite, and therefore H and B definite through all space. Of this a variety of proofs may be given (the first was given by Sir W. Thomson in 1848, relating to similar equations, μ being isotropic); the following perhaps puts the matter in as simple a form as it can be put, and is best adapted to the present circumstances.

In the first place there cannot be two solutions of (38) for F. For if (38) are satisfied by F and also by F + f, we have, by subtraction,

$$\mathrm{div.}\mu f = 0, \quad \mathrm{curl}\, f = 0, \quad . \quad . \quad . \quad . \quad (39)$$

as the equations that f must satisfy. But consider the quantity $\Sigma f\mu f$ integrated through all space. It cannot be negative, for every element of it is positive or else zero. Thus

$$f\mu f = \mu_1 f_1^2 + \mu_2 f_2^2 + \mu_3 f_3^2;$$

if μ_1, μ_2, μ_3 be the principal permeabilities, and f_1, f_2, f_3 the corresponding components of f. We suppose the permeability always positive (to deny this would lead to absurdities), hence $f\mu f$ is always positive, or else zero, viz., when $f = 0$. But, by the second of (39), $f = -\nabla p$, if p is the potential of f, and therefore, by a potential property,

$$\Sigma f\mu f = \Sigma . p\, \mathrm{div.}\mu f \quad . \quad . \quad . \quad . \quad . \quad (40)$$

and therefore vanishes, by the first of (39). Hence $f = 0$, making the supposed two solutions identical.

Next, to show that there is one solution, consider $\Sigma\mathrm{H}\mu\mathrm{H}$ through all space. This is also positive, or zero, whatever H may be, by the same reasoning, so has necessarily a minimum value. If H be quite arbitrary, the minimum is zero, when H = 0 everywhere. But H = h + F, and here h is constant. Let F vary. The corresponding variation in $\Sigma\mathrm{H}\mu\mathrm{H}$ is

$$\delta\Sigma\mathrm{H}\mu\mathrm{H} = \Sigma\delta\mathrm{F}\mu(h + \mathrm{F}) + \Sigma(h + \mathrm{F})\delta\mu\mathrm{F} = 2\Sigma\delta\mathrm{F}\mu(h + \mathrm{F}). \quad (41)$$

Now subject F to either of the two equations (38), say the second, so that $\mathrm{F} = -\nabla\Omega$. Thus, similarly to (40),

$$\delta\Sigma\mathrm{H}\mu\mathrm{H} = 2\Sigma\delta\Omega\,\mathrm{div.}\mu(h + \mathrm{F}). \quad . \quad . \quad . \quad (42)$$

Hence, to make $\Sigma\mathrm{H}\mu\mathrm{H}$ a minimum requires $\mathrm{div.}\mu(h + \mathrm{F}) = 0$, which is the first equation (38). Thus, when F satisfies both equations, it makes $\Sigma\mathrm{H}\mu\mathrm{H}$ a minimum. But this quantity *has* a minimum, therefore there *is* a solution of the equations (38), or F is a definite vector for every point of space.

If we assume that μ contains a rotatory vector ϵ, so that

$$\left.\begin{aligned} \mu\mathrm{H} &= \mu_0\mathrm{H} + \mathrm{V}\epsilon\mathrm{H} \\ \text{let} \quad \mu'\mathrm{H} &= \mu_0\mathrm{H} - \mathrm{V}\epsilon\mathrm{H} \end{aligned}\right\}, \quad . \quad . \quad . \quad . \quad (43)$$

then μ' is conjugate to μ, and $\frac{1}{2}(\mu + \mu')\mathrm{H} = \mu_0\mathrm{H}$, where μ_0 is self-conjugate or non-rotatory. Instead of (41) we shall have

$$\delta\Sigma\mathrm{H}\mu\mathrm{H} = 2\Sigma\delta\mathrm{F}\mu_0(h + \mathrm{F}), \quad . \quad . \quad . \quad . \quad (44)$$

and the minimum is given by $\mathrm{div.}\mu_0(h + \mathrm{F}) = 0$, which is not the proper condition.

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There is a similar failure in the mathematically analogous problem of conduction current kept up by impressed electric force, when the conductivity k is rotatory.

In connection with the above, we may notice two special solutions of (37). First, if curl $h=0$, then curl $H=0$, which, with div.$\mu H=0$, requires $H=0$, and therefore $B=0$. That is, if the impressed force be wholly polar, there is no induction. The simplest example is a closed magnetic shell of uniform strength, and any thickness, an assemblage of magnets put together side by side in such a manner that there is no induction anywhere.

Secondly, if div.$\mu h=0$, then div.$\mu F=0$, which, with curl $F=0$, requires $F=0$, therefore $H=h$, and $B=\mu h$. Here the impressed force everywhere produces the full induction, and there is no polar force.

Comparing our equations with those occuring in the problem of magnetisation, we find that, if I be the intensity of intrinsic magnetisation, it is related to h, thus

$$I=\mu h/4\pi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (45)$$

h may therefore be called the intrinsic magnetic force, if we like. The real magnetisation is the sum of the intrinsic and the "induced," which we shall call i, and the ordinary form of the magnetic induction equation is

$$B=F+4\pi(I+i), \quad . \quad . \quad . \quad . \quad . \quad . \quad (46)$$

where F is the polar force due to both the intrinsic and the induced magnetisation. It is the same as F above. And to identify (46) with the equation $B=\mu H$ we use always, we have first

$$i=\kappa F,$$

giving the induced magnetisation in terms of the polar force, κ being the coefficient of induced magnetisation, next the equation (45), and lastly, $\mu=1+4\pi\kappa$; so that (46) becomes

$$B=F+\mu h+4\pi\kappa F=\mu(h+F)=\mu H \quad . \quad . \quad (47)$$

It will be seen that this separation of magnetisation into intrinsic and induced is a roundabout way of treating the subject, and that there is considerable simplification obtained by always using the equation $B=\mu H$, both in an intrinsic magnet and without it, ever employing the two ideas of magnetic force and magnetic induction, and letting magnetisations alone. The quantity B is the magnetic induction as ordinarily understood, H is also the magnetic force as ordinarily understood everywhere, except where there is intrinsic magnetisation. There, however, we add the intrinsic or impressed force h, making $H=h+F$ in general, just as in a conduction current system we add the impressed force where there is any to the polar electric force and that of induction to obtain the resultant efficient electric force. H is thus always the resultant magnetic force from all causes, and although in the above we have considered no electric currents to exist, yet we may add that should there be any, H will be equal to $h+F+F_1$, where F_1 is the magnetic force of the current; and $B=\mu H$ always.

The term "intrinsic," as applied to magnetisation, is used by Sir W. Thomson, but not by Maxwell, though he gives the same theory of induced magnetisation as the former. It is not always clear in Maxwell's treatise whether by magnetisation he refers to the intrinsic only or to the actual, including the induced. Maxwell's equations of disturbances also break down when they are applied to the interior of an intrinsic magnet, owing to his use of the equation curl $H=4\pi\Gamma$, as the relation between the magnetic force and the current, whereas it must be (equation (32)) curl $(H-h)=4\pi\Gamma$, where there is intrinsic magnetisation, if we are to obtain consistent results.

Although in identifying I with $\mu h/4\pi$ we have, by means of the two equations of induction (32) and (33) and the equation of energy deduced therefrom, obtained a justification of the energy definition of h, similar to that for impressed electric force, yet as the consequences are of some importance in variable states, they may be advantageously followed up from the impressed force point of view.

Magnetic Energy. Double work of Magnet.

Let there be a distribution of impressed magnetic force h in a medium of given variable permeability μ—for example, a magnet in air containing soft iron and any other substances. Imagine the impressed forces to be put on suddenly. We know, by the above, that a certain definite distribution of magnetic induction is set up, which is steady when the arrangement of matter is fixed. During the transient state there is magnetic current everywhere unless $\mu=0$ somewhere, which we must believe to be impossible, since μ is very little less than unity for any known substance. The magnetic currents are wholly closed. They are accompanied by electric currents, also closed, in all space, in general. When they have ceased, there is no electric force anywhere, and the magnetic induction at any point is the time-integral of the magnetic current $\times 4\pi$. Compare the work done by the impressed forces with that done by the actual forces through all space. The latter is, per unit volume,

$$\int HG\,dt=\int H\mu\dot{H}/4\pi.dt=\int\frac{d}{dt}(H\mu H/8\pi)dt=H\mu H/8\pi.$$

where in the last expression H is the final value of the magnetic force. In the integrals, H is the variable value at time t. Let T be the whole work thus done in all space, then

$$T=\Sigma H\mu H/8\pi. \quad . \quad . \quad . \quad . \quad . \quad . \quad (48)$$

On the other hand, the work done by the impressed force per unit volume is

$$\int hG\,dt=\int h\mu\dot{H}/4\pi.dt=h\mu H/4\pi\ ;$$

so, if T_1 is the whole work done by the impressed forces,

$$T_1=\Sigma h\mu H/4\pi, \quad . \quad . \quad . \quad . \quad . \quad . \quad (49)$$

where the summation may also extend through all space, since where there is no h nothing is contributed to the sum. Now $H=h+F$, and

$$\Sigma F\mu H=\Sigma\Omega\text{div}\mu H=0, \quad . \quad . \quad . \quad . \quad (50)$$

because F is polar and μH solenoidal. (Similar to (40).) So in (49) we may add F to h, making

$$T_1=\Sigma(h+F)\mu H/4\pi=\Sigma H\mu H/4\pi=2T, \quad . \quad . \quad (51)$$

by (48). The impressed forces therefore do double the work of the actual magnetic forces during the transient state. The excess is done by the electric forces. For, integrating (28), to the time, with $e=0$, and also through all space, to get rid of W,

$$\Sigma\int hG\,dt=\Sigma\int E\Gamma dt+\Sigma\int HG\,dt;$$

and, since finally $U=0$, we have

$$T_1=\int Q\,dt+T. \quad . \quad . \quad . \quad . \quad . \quad . \quad (52)$$

Hence, by (51), $T=\int Q\,dt$, the total heat in conductors arising from induced currents.

One half the work done by the impressed forces is wasted in heat of induced currents, the other half is the magnetic energy set up, expressed by (48). Now, suddenly remove the impressed forces; there will be a similar inverse transient state, during which, as the magnetic induction subsides, the whole of the energy T will find its way to the conducting parts to be there wasted as heat. The intrinsic magnet itself, it should be remembered, would come in for a large share of this; in general, or, in special cases, the whole. T is thus the whole amount of work that can be got out of the magnetic system by removing the intrinsic forces, which is why we term it the magnetic energy.

It may be objected that the above is unrealisable, that we cannot put on, or suddenly remove, the retentiveness of a magnet, and so obtain the whole magnetic energy existing in a given configuration in work. Admitting this, it may be remarked that we can do something equivalent, or at least approximate thereto, in the following manner. By means of a properly chosen distribution of impressed electric force we may set up electric current that shall exactly neutralise the field of the magnet, producing a state of no induction. Now suddenly cut off the impressed electric forces that kept up the currents. We then start with no induction, and terminate with the proper distribution of induction due to the magnet, and the impressed electric forces do no work, being cut out. Hence the effect is the same as suddenly putting on the impressed magnetic

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forces, doing 2 T of work, one half magnetically, the other half being expended in the heat of induced currents. Some simple examples to illustrate this will be worked out later.

This extreme case will serve to illustrate the meaning of the distinction between the work done by h and by H, also the meaning to be attached to magnetic energy. There are other ways of course of using up the energy T above said to be wasted in heat. Thus, if we alter the configuration of the matter in our magnetic system, we usually alter T. Let it be increased from F to F + δF. Thus the impressed forces h will do 2δF of work, one half magnetically, in increasing F, the other half mechanically, by the mutual stresses assisting the motion, and this latter half will be partly wasted in heat at once by the induced current accompanying the motion, and all may be ultimately thus wasted.

This naturally brings us to the subject of the mechanical forces.

(TO BE CONTINUED.)

CORRESPONDENCE.

THE WIMSHURST ELECTRICAL INFLUENCE MACHINE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In two lectures recently delivered by Professor J. Lodge at the London Institution on "The Nature of Electricity," it was often said, he remarked, that we did not know what electricity was; and Professor Tyndall, in a recent lecture on "The Sources of Electricity," stated that it would take him some time to go through the philosophy of the above machine, nor was he sure that he could do so; but I think that by capitalising the facts associated with electricity and the *influence* machine, we shall be not only able to show that our ignorance of electricity is not so great as some would make it appear, but also to solve the principles which govern the action of the machine.

It is a well established fact that if a metal in solution be subjected to the influence of electricity it may not only be precipitated on another metal, as in the process of electroplating, but is also made to firmly adhere to the metal, thus affording evidence of there being in the current the "forces" of attraction and of cohesion, and I need scarcely state that it has the property of crystallising.

If a quantity of a salt be put into a pan and subjected to heat, the salt is decrystallised and dissolved; and if that hot solution be placed on straw, or other insulating medium, in a dark corner, out of doors, during a hard frosty night, when the thermometer is considerably below the freezing point, flashes of light may be seen to go to the pan, and the salt crystallises. Here, then, we have evidence that what we call heat has a disentegrating influence, whilst cold has the property of combining.

Neither ordinary cold nor heat will travel along a wire, if even the wire be connected with a hot body or a lump of ice; but if that ice be mixed with salt, and the combining agent in both the salt and ice be set free, as in the freezing mixture, the *intense* cold will find its way to a hot solution through a very fine copper wire, some 12ft. long, and cause the crystallisation of salt; and I have not the slightest doubt but that a similar result might be obtained by connecting a solution with an internal wall of a building during hard frosty weather. I know that a solution of alum so connected, when a summer sun was shining in full on the exterior of the house, was retarded in its crystallisation, and hastened when the same wall was influenced by a heavy shower.

Facts of the above nature, all tending to the same conclusion of the relation of heat and cold to electricity, may be adduced by the dozen; and if air be subjected to the influence of compression, and turned into a chamber where meat is suspended, the meat is not only frozen but may be kept in the frozen state during its transit from the Antipodes. If, however, instead of its being set free, the air be compressed into a tank or iron vessel, having a nozzle at an angle of 45°, on the valve being turned the escaping air will send an india rubber ball spinning in the direction of the jet. The ball takes the oblate spheroid form, then collapses, still spinning on its centres, and if the valve be partially closed, the ball, instead of falling, actually returns to the nozzle, thus affording conclusive evidence that, associated with the foregoing influence of compressed air, there is in it a "force" that overcomes gravitation.

It will no doubt be within the remembrance of my readers of mature age that in 1845 there was at the Polytechnic Institution an "electrical boiler" of gigantic electrical powers. After a number of sittings of observation, I solicited of and obtained from the directors permission to make certain experiments, and in my application I observed that the electricity on going to the boiler, &c. But on my arrival I was told by Professor Bachoffner that the electricity did not go to the boiler at all, but only from it with the steam, an error of which I convinced him by presenting my head to the machine when in full action, and sending from it three flashes of electricity at least 6in. long.

At that time (1845) I thought the electricity was blended with the steam, but having at a later period conceived the law that all heated or incandescent bodies, such as a burning taper, fire, or redhot piece of iron, are surrounded by an atmosphere electrical in proportion to the incandescence, and a close inspection of an oak that had been struck by lightning, I came to the conclusion that it was the outside of the boiler that became electrical, and that the electricity blended with the negative steam in its escape. But whilst I must allow that the question is open to consideration, which it assuredly should have without loss of time, I can unconditionally aver that compression, under all circumstances, induces electricity; and if the matter compressed be of a cohesive or sticky nature, such as hops, meal, or wood, it actually increases in weight. This increase of weight by compression I deduced, in 1848, when writing a paper for the then Board of Health, and which paper was first printed in *Newton's London Journal*. That matter in gravitation is repelled by the surrounding regions in proportion to its electrical condition, and therefore must increase in weight in proportion to the quantity of electricity acquired by the compressing influence.

About the close of the year 1880, there appeared an article in the *Engineer* respecting the Reese fusing disc, which consists of a thin disc of soft steal that is made to revolve with great velocity. If there be placed in front of it a round bar of cast steel, it will cut that bar in two in the same way as a soft iron disc cuts up old steel railway rails—that is, by detaching particles of the metal, which particles, by combining with the oxygen of the air, produce sparks. But if, on the contrary, the round bar of cast steel be made to revolve at a much less rate than the soft steel disc, the disc, without touching the bar, actually makes its way through it, the steel of the bar so turned out being converted into a mass of the consistence of putty or butter.

This fact was necessarily declared to be opposed to all preconceived notions, but, as I observed at the time, allowing that centrifugal force should produce electricity, evidently that of the round bar would be of much less tension than that of the disc; and if the latter, being directed on a small part only of the bar, should cause the electricity of the bar to flow to that spot, the concentrated influence would necessarily induce a negative state in the bar in front of the disc, to the withdrawal of the bond of union, and production of the butter of steel.

In the days of the imponderables, heat, light, and electricity, the first was the all-pervading agent, and the other two effects only; but some time about or before 1830 there appeared a very long correspondence between two of our then greatest authorities—one in London and other on the other side of the Atlantic—on the nature of heat, and as that discussion terminated in neither being convinced, it produced in me the consideration whether the subject itself must not be at fault; and by compiling a host of facts, but carefully excluding the opinion of our authorities, I obtained conclusive evidence that heat was nothing more than an effect; that, in fact, it was the absence of cold.

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It was, however, some fifteen years later, at the close of an inquiry on the general properties of matter, that the magnitude of my subject became apparent, and in 1845 I produced my first paper in the *Mechanics' Magazine* on the Constitution of Snow, and other such questions, in all of which electricity was an agent and not merely an effect; and this was followed by a series of papers in the *Chemist* from April to October, inclusive (1847), on various subjects connected with electricity. Now, however, by the accompanying extracts everything is to become electricity.

"Mr. T. A. Edison, of Menlo Park, New York, has always been rather conspicuous for the speculative boldness of his ideas, and if he had not actually done some very marvellous inventive feats he might be regarded—or disregarded—as a mere dreamer of dreams. Too many of his dreams have been fulfilled, however, to permit of his being deemed unworthy of the most serious attention, however apparently wild may be his scientific forecasts. He has just given, in the New York *Tribune*, expression to one which certainly looks to be very wild indeed. As everybody knows, an enormous amount of capital and ingenuity has been devoted to the creation and perfection of machinery for the generation of electricity. Mr. Edison now ventures on the prediction that many now living will probably see the time when all this machinery will be unnecessary, and when electrical energy will be derived directly from coal, which is stored up solar heat and light. The notion of certain French and German scientists, that solar light and heat may by and by be tranformed directly into electricity, the New York prophet scouts as mere wild chimera, or at any rate as something too remote and untrustworthy to be within the limits of practical science; but that the transformation will before very long be effected directly from the coal he believes to be a 'certain fact.'"

I can assure Mr. Edison that our coal beds were laid down in the absence of sun, and that the heat and light we get from coal proceed from chemico-electrical action.—Yours, &c.,

ELECTRICAL CONDITION OF 1848.

20th February, 1885.

ELECTRICAL UNITS, &c.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I think we ought all to thank your correspondent, Mr. Swinburne, for his outspoken remarks upon the present hopeless confusion in our standards of measurement. It appears to have occurred to him, as it no doubt has or soon will occur to others, that when examining at least the units of electricity and light it is not only expedient but absolutely necessary to lay aside coloured spectacles.

There is one factor of paramount importance in every calculation—and specially affecting physical science—which ought to be, and is supposed to be, absolutely fixed and accurately determined. That factor is mass. The slightest error regarding it involves everything connected with it, and leads to an unceasing attempt to invent new definitions (?) and hypotheses for the purpose of avoiding the difficulties to which that error leads, and hiding, under an apparently transcendental perfection, an imperfection which only those who dare to lay aside spectacles fully realise.

I have for over twenty years past been examining that factor and its relation to weight. I wrote fifteen months ago to an eminent authority, respectfully stating that mass did not always vary directly as weight, and that only those who never dare to face facts could now conclude that it did. The reply I got was, "calculation goes to show that it must, and experiment agrees with such calculation."

I allowed twelve months to pass and wrote the same authority again, stating that with the most careful procedure, and after taking precautions beyond those of Cavendish and Baily (whose experiments incidentally bear well upon this question), I found mass did not vary directly as weight experimentally. Mark the difference of the reply. Its effect is this: "There is no *à priori* reason for saying that mass varies directly as weight, it simply depends upon two experiments, one 200 years old, the other made in 1826."

How gratifying it must be to know that the whole scientific edifice is supported by two (!) experimenters' results. If experiments were necessary at all, why not more? If the proposition was self-evidently true, why make any experiments at all?

Faraday was wiser than his feeble imitators when he concluded the chemical atoms were "centres of force."

My experiments prove that mass must be taken out of all our formulæ, and written down as energy. If it is asked what is to become of all the imposing terms, equations, and proofs of our mathematicians and speculators, I reply they must and will accommodate themselves to fact. No one who knows their enormous modulus of elasticity can doubt their ability to do so when they are made.

The change may be made now or deferred, as your correspondent says, till doomsday; but the latter alternative will only perpetuate what he well terms patchwork, and hold out inducements to those he refers to and their *clientèle* to postpone their retirement to the congenial shades he indicates, where, if they had gone long since, with the whole stock in trade of coloured spectacles and without return tickets, we should have had less reason to say to-day what true men of science all over the world feel, viz., that there is something rotten in the state of Denmark.—Yours, &c.,

W. H. SHARP.

18, Gertrude-road, Anfield, near Liverpool.

INCANDESCENT LAMPS AND THEIR HOLDERS.

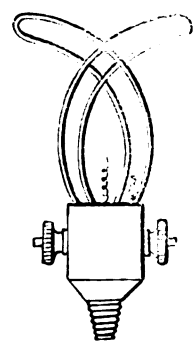
TO THE EDITOR OF THE ELECTRICIAN.

SIR: If I am not trespassing too much upon your valuable space, perhaps our experience in this matter may be interesting.

We have never departed from the original plan of loops at the bottom of the lamp; and up till very recently we could find no better form of holder than the old Swan, with the large spiral clasping the neck of the lamp.

The loops of many of the earlier lamps were often exceedingly troublesome. Now one would break a loop off close to the glass, and another time the loop or the hook would fuse. But as the manufacture improved, and the men who had to change the lamps became more accustomed to the work, and more handy with their fingers, these difficulties gradually disappeared.

It was rather difficult to hook on a lamp to the old Swan holder in the dark, as I have had to do underground in a colliery, or with only the dim light of a miner's lamp, but with the cross holder which we have now been using for some



time we have very little trouble, as the connections are not hidden by the sprays, and they are easily hooked to the loops, no matter how erratic the latter may be. One thing we discovered rather early, wherever there is much vibration a rigid holder soon shakes out of contact, and is therefore useless.

I think that the loop form carefully made, with platinums rather stronger and a holder something after the style of the sketch enclosed, should fulfil all requirements.

Mr. Cox-Walker's holder, like everything issued by his firm, has evidently been very carefully worked out and is well made. Time will show if it possesses sufficient advantages to warrant the extra cost over other forms.—Yours, &c.,

SYDNEY F. WALKER.

195, Severn-road, Cardiff, March 10, 1885.

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A PERSONAL EXPLANATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am informed that the expression "Mr. Wright, one of the members of our class," in Professors Ayrton and Perry's paper, read at the Physical Society, and published in your last issue, conveys, though doubtless quite unintentionally, the idea that the result communicated to you in my letter of the 12th ult. was obtained from Professor Ayrton's lectures, which I have been attending (I have never attended any of Professor Perry's).

I therefore ask you to allow me to state the facts. Professor Ayrton pointed out in one of his lectures the importance of establishing the relation between the life of incandescent lamps and the volts used; but he recommended to try for a rectangular hyperbola, nor has he even once mentioned the logarithmic relation, which I communicated to you, or any resembling it. My letter was in the printer's hands on Thursday, the 12th ult. On Monday, the 16th, I told Professor Ayrton that I had found the required equation, which he thereupon took down in his study from my dictation, and we spent some time in adapting it to the lamps at the college.

The next day Professor Ayrton informed me that the matter had been worked out by Professor Perry two or three days before.

Finally, I am glad to say that when I told Professor Ayrton that I had sent the working to *The Electrician*, he replied, "Certainly, certainly," with emphatic approval.—Yours, &c.,

F. M. WRIGHT, M.A. (Oxon),
Assistant Teacher of Mathematics,
March 9th, 1885. Finsbury Technical College.

THE COX-WALKER LAMPHOLDER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your kind notice of the above in last week's issue, will you allow me to say with reference to your suggestion as to the possibility of any shadow from the supporting wire, that in order to make this entirely imperceptible I have reduced the thickness of the wire to a mere line; and also I must remind you that this support may be *dispensed with altogether*. The fittings may be nickel plated, and the nipping plates platinised; but the latter process would add to the cost.—Yours, &c., E. COX-WALKER.

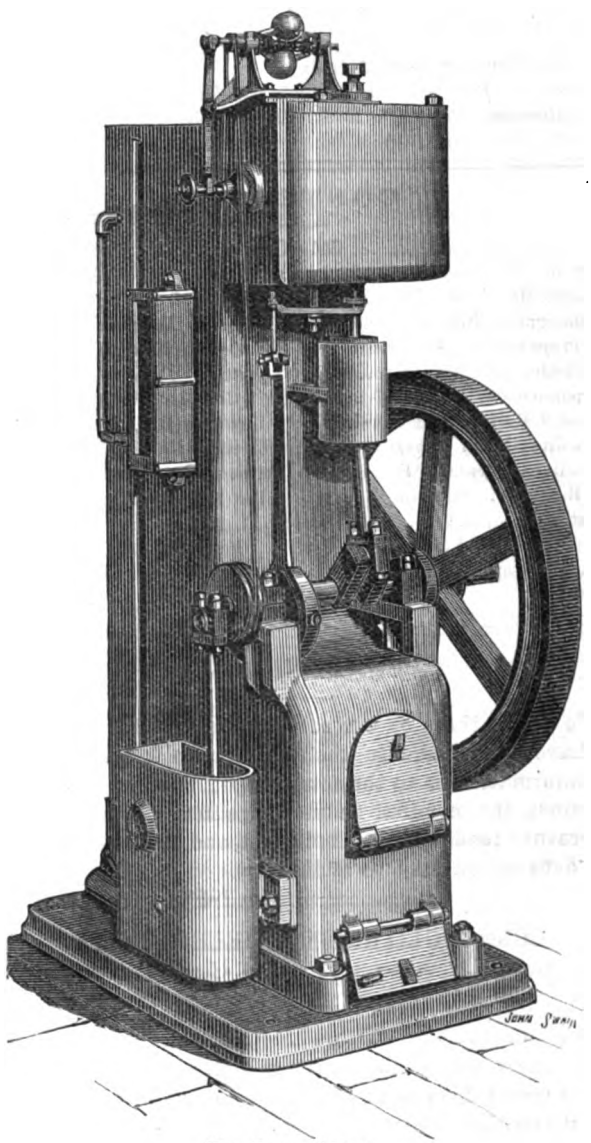
Darlington, March 9, 1885.

THE DAVEY MOTOR.

The Davey small-power motor, shown by the accompanying illustration, is being used for electric lighting, it being found that, with a good dynamo, nine incandescent lamps may be supplied with current for each indicated horse-power. The engine was originally intended for powers of from half to two horses, but is now made up to 4 horse-power indicated. It is double-acting, being supplied with steam at or just below atmospheric pressure, subsequently condensed. About a gallon of water per horse-power per hour only is required; and it can be used over and over again by employing a small tank. Careful experiments have shown the consumption of gas coke to be 8lb., costing about a farthing per indicated horse-power per hour.

In external form, the engine somewhat resembles a single-standard steam-hammer, the cast-iron boiler forming the frame. The fire-box and up-take, cast in one piece, are placed inside the boiler, being connected therewith by cement joints, caulked into the sockets left to receive them in the top and bottom of the shell, the fire-hole joint being made by a ring, coated with red-lead cement, driven in tight. A projection in the upper part of the boiler receives the gun-metal cylinder, which is thus continually surrounded by steam. An ordinary slide-valve, without any valve-chest, admits the steam to the top and bottom of the cylinder, while a stop-valve serves for starting and stopping. For electric lighting, a high-speed governor is added for securing a constant speed. The piston-rod, working in a cylindrical guide, actuates the connecting rod and crank shaft in the usual manner, the bearings being cast in one with the boiler. The crank-shaft carries an eccentric for working the slide-valve, a disc crank for the air-pump rod, and a fly-wheel which serves as pulley for driving. The fire-hole and ash-pan doors are seen in front, below that part of the boiler which does duty for bed-plate. The plunger of the single-acting air-pump is not packed; when near the bottom of its stroke, it uncovers a small hole, which allows water from the hot well to fall back into the plunger and over its edges, thus forming a water seal.

The boiler is fed from a closed feed-chamber, cast on the side of the condenser above the hot well. This chamber is in free communication with the boiler by two passages leading, the large one into the steam space, and the small one to the boiler below the water line, so that the water in the feed-chamber stands at the same level as in the boiler. The feed-chamber is supplied with water by a pipe with cock, having a nozzle which projects into the chamber, the nozzle being fitted with a plug and float. The float falls with the water, thus admitting more water until the proper level is restored. To start the engine, steam is got up until it blows through a loose cover at the top of the boiler, thus expelling the air; and on the engine being turned round, thus blowing through the condenser, a partial vacuum is formed, the motor working like an ordinary condensing engine. It is, however, found to work best when



The Davey Motor.

steam is kept just below the blowing off point, or practically at atmospheric pressure, as, in that case, air does not enter at the piston-rod and valve-spindle stuffing boxes; it will, however, work with several inches of vacuum in the boiler.

The vacuum obtained in the condenser is 25 to 26in., and an experiment was made to show the degree of vacuum required to overcome the friction of the engine and resistance of the air-pump, with the result that, with a condenser vacuum only 5in. of mercury lower than the boiler pressure, the engine ran at its normal speed. As, under ordinary working conditions, the difference between the boiler and condenser pressures is about 25in. of mercury, there is an available margin of 20in. of mercury, or say 10lb. per square inch above that required to overcome the friction of the engine. This shows an efficiency of 80 per cent., not a bad result; and, working at atmospheric pressure, the Davey motor is no more liable to burst than a tea-kettle, while, as the boiler is self-feeding and the fire can be made up to last for a long time, the least possible attention is required.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

COSMOPOLITANISM IN ELECTRICITY.

In a few days the International Society of Electricians, whose headquarters are at Paris, is to justify its existence. This society is an outcome of the Electrical Exhibition of 1881. The electrical world then met at Paris, and, among other things, succeeded in discussing the question of units. It was felt that isolation in matters scientific was far from beneficial, and it was hoped that an international society would find work to do of a general character. There is plenty of work—the only question is, what class of work should be left to a cosmopolitan society? Next week the members of the society and those who are favoured with invitations and can go to Paris, will have provided for their edification an exhibition consisting of some hundred and forty or hundred and fifty exhibits, in addition to a series of papers to be read and discussed day by day by some of the most eminent scientific men of France. It may not be too late to alter the programme, and, if not, it might be suggested that a clear and distinct individuality be given to the society. We do not want to hear the ordinary run of papers usually read at electrical conferences; nor do we want papers containing the history and results of original research. The various "learned" societies provide an outcome for pabulum of this kind, while they have not sufficient power to determine other matters. Some years ago it was suggested to our own Society of Telegraph Engineers that it should form a committee to investigate and authoritatively decide, so far as Great Britain was concerned, questions of notation and nomenclature. A paper on this subject is just now before the society for discussion. We are necessarily writing before the ordinary meeting of the society, when the paper is to be read by one of the members of the society. Such a paper carries absolutely no weight. It is a record of individual opinion, and nothing more. The suggestions made in the paper may be adopted or may be rejected at the whim of any writer. The case would be vastly different if the society itself issued an authoritative notation, which should be made compulsory in papers submitted for reading and insertion in its journal. We could guarantee that if a notation was thus authorised, one authorised after due consideration, and recommended by a sufficiently strong and dispassionate committee, the technical press—so far, indeed, as regards that portion of it commanding or compelling respect—would accept with thankfulness the notation. A step further takes us to the International Society, and one of its objects we maintain should be to secure a universal notation and nomenclature for the use of electrical students. Pure science is having under its auspices an innings for the strict definition and determination of "units." While admitting the great desirability of settling the question of "units" once and for all, we see little prospect of such a settlement. The existing race of scientific men act and talk as if they had arrived at finality. Why, next year or next week may produce a discovery that would necessitate the modification of what has been or is to be strictly settled. Practical men are beginning to kick at the constant ringing of the changes, and who can blame them? It is altogether different with questions of "notation." A universal system might easily be adopted without interfering in any way with national or personal prejudices. Such a universal system would be very valuable to students, to writers, and to readers. We know of one small English society, formed in the interests of a particular application of mathematical knowledge, which has recognised the want of a systematic notation, which has discussed and decided upon the notation, and has seen its work adopted throughout the civilised world. Most of our readers know that this question of notation is one that we have from time to time discussed for many years past, and if we urge the members of the International Society, or the members of the Society of Telegraphic Engineers, to make common cause in getting a system adopted, it is because we believe an authoritative settlement would be beneficial in all directions.

Other important questions might be suggested for the consideration of the cosmopolitan—such as the one for which we have asked the co-operation of readers, viz., the changes which take place in "condensers." Valuable work would be done by those who have charge of condensers if they would write a daily history of the apparatus in their charge. Then we have the changes which take place in the wire, &c., subject to electrical use. But it is sufficient to throw out a suggestion, and not necessary to follow it into all its details.

In conclusion, we may say that the meeting of the society will last for seven or eight days, and be held at the Paris Observatory. The Exhibition will be opened daily from one to five and from eight to eleven. There will be one or two conferences each evening in a special room. The meeting of the society was fixed for the 15th inst; but at the moment of going to press we have been informed by telegraph that the

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opening of the Exhibition and Conference will be delayed for eight days. This delay will permit of some modification of the programme in the direction we have indicated, if it should be found that such modification would meet with general approval.

ALTERNATING CURRENTS.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 327.)

Before discussing some of the effects upon the practical applications of electricity of coefficients of mutual and self-induction, it will be well to consider the action of a condenser whose plates are joined to different points of a circuit conveying an alternating current, for we shall find that in cases where both capacity and coefficients of induction exist, they are capable not only of modifying the effects of each other, but of masking the effects of resistance. It may even be possible by suitable adjustment of the quantities concerned to put through a resistance which is not closed a current of the same amount which would flow through it if it were closed, but denuded of the condensing apparatus and induction coefficient.

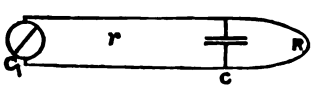

FIG. 6.

In Fig. 6 suppose that G is a source of harmonically varying electromotive force, working into a circuit whose total resistance is $\overline{R+r}$, and that at C there is a condenser of capacity C connected with the circuit in such a way that the section of the circuit terminated by the plates of the condenser and containing the source G has a resistance r, and that the remote section has a resistance R. We shall also suppose that there is no self-induction in either section of the conductor. Take a straight line, O C, on any convenient scale to represent

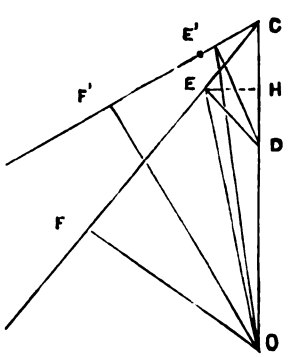

FIG. 7.

the electromotive force of the source, and divide O C in D so that O D : D C :: r : R.

Calculate the quantity $\frac{C\pi Rr}{T(R+r)}$, where T is half the period.

From the nature of the units involved this quantity is necessarily positive and numerical, and it may therefore be represented by the tangent of an angle in a diagram where the lines, as in the case before us, are electromotive forces.

Set off the angle O C E of such a value that its tangent has this value, and in the direction of retardation. From D draw D E perpendicular to C E, and join E O. Then O E and E C will represent in phase and magnitude the effective electromotive forces in the two sections. That is to say, the current generated in r will be that due to an E.M.F. of the value O E operating upon a simple circuit of resistance r, and the current generated in R will be that due to an E.M.F. of the value E C operating upon a simple circuit of resistance R. To prove this, produce C E to F, and draw O F perpendicular to C F.

In the first place it is to be observed that the difference of potential of the plates of the condenser constitutes the effective electromotive force in the circuit R. Also the difference between the generated E.M.F. and that due to the plates of the condenser constitutes the effective E.M.F. in the circuit r.

But the generated E.M.F. is O C. If, therefore, E C does represent the E.M.F. due to the condenser—*i.e.*, the effective E.M.F. in section R—it follows that O E will represent the effective E.M.F. in section r. Thus the two points to be proved stand or fall together, and we may prove the proposition by a *reductio ad absurdum*.

Thus, if E C is not the effective E.M.F. in circuit R, let E′ C be the value in phase and magnitude. Join E′ O, E′ D, and draw O F′ parallel to O E′.

Now, because E′ C represents the effective E.M.F. in R, therefore O E′ represents the effective E.M.F. in r.

Therefore $\frac{E'C}{R}$ is the effective current in R,

and $\frac{OE'}{r}$ is the effective current in r;

but F′ E′ : E′ C :: O D : D C, because O F′ is parallel to D E′.

Therefore F′ E′ : E′ C :: r : R,

and hence $\frac{F'E'}{r}=\frac{E'C}{R}$.

Therefore $\frac{F'E'}{r}$ is the effective current in R,

and since $\frac{OE'}{r}$ is the effective current in r, therefore the currents $\frac{OE'}{r}$ and $\frac{EF'}{r}$ are those currents considered as conveying electricity *into* the condenser, the positive current in r being of course a negative current as regards charging the condenser. But these are the only two currents affecting the condenser; therefore $\frac{OF'}{r}$ is the effective charging current of the condenser—*i.e.*, the phase and magnitude of the effective E.M.F. through a resistance r, and producing the effective charging current, is represented by the line O F′. But, by what was proved in the last chapter, the phase of the charging current must differ by a quarter period from that of the difference of potential of the plates of the condenser.

Therefore O F′ must be at right angles to C E′, and the angle D E′ C is a right angle. Therefore E′ must lie in the circumference of the semi-circle described upon C D as diameter.

Further, since $\frac{OF'}{r}$ is the effective charging current, the maximum accumulation of electricity is $\frac{OF'}{r}\frac{T}{\pi}$, and therefore, if C is the capacity of the condenser, the difference of potential of the plates of the condenser will be $\frac{OF'}{r}\frac{T}{\pi}\frac{1}{C}$, which therefore should be equal to E′ C.

But O F′ : E′ D :: C O : C D by similar triangles.

$$:: \overline{R+r} : R$$

$$\therefore OF'=E'D\,\frac{\overline{R+r}}{R}$$

Hence $$E'D\,\frac{\overline{R+r}\,T}{rR\pi C}=E'C$$

Therefore $$\frac{E'D}{E'C}=\frac{C\pi Rr}{T.\overline{R+r}}$$

or tan D C E′ = tan D C E.

Therefore C E′ must coincide with C E in direction, and because E′ lies upon the semi-circle on D C, it can occupy no other position than E; or E C is the effective E.M.F. in R, and by consequence O E is the effective E.M.F. in r.

The only point remaining to be justified is the direction in which the angle O C E has been taken. Had it been taken on the other side of O C, it is clear that E C would be at a maximum a quarter period *before* $\frac{OF}{r}$, the effective charging,

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which would be absurd. Hence the construction is completely justified.

Now, it is evident, from the mode of construction, that O E must always be greater than O D. But had there been no condenser in the system, it is clear that O D would have been the effective E.M.F. through the resistance r. The effect of the condenser, then, has been to increase the effective E.M.F. in this section, and of course also to increase the current resulting from it.

On the other hand, E C must necessarily be less than C D, which is the longest side of a right-angled triangle, of which E C is one of the other sides. But without the condenser C D would have been the effective E.M.F., through the section whose resistance is R. The effect of the condenser in the system upon this portion of it will be, therefore, to diminish the current.

Hence, if the whole circuit before the introduction of the condenser contains a number of incandescent lamps in series, the joining up with the plates of the condenser will have opposite effects upon the lamps in the two portions of the circuit. The light of those situated between the condenser and the generator will be augmented, and that of those in the remote section will grow less intense. This effect depends entirely upon the value of the tangent of the angle O C E, which is equal to $\frac{C\pi Rr}{T(R+r)}$, and therefore increases as the capacity of the condenser increases, and as the period diminishes.

A further question is that of the change of power employed. By what was demonstrated in the first article, the power of the source of any harmonic source of E.M.F. is equal to half the product of the E.M.F. and the current passing through it, multiplied by the cosine of their difference of phase.

In the case before us the E.M.F. of the generator is O C; the current through it is $\frac{OE}{r}$.

Therefore the power is $\frac{OC.OE}{2r}.\cos COE$.

If E H is drawn perpendicular to O C,

$$OH = OE\cos.COE.$$

Therefore the power employed is $\frac{OC.OH}{2r}$.

But had there been no condenser, or if the capacity of the condenser vanishes, O H would have been coincident with O D, and the power would have been $\frac{OC.OD}{2r}$.

Therefore the effect of the condenser has been to demand a change of power in the ratio of O D : O H.

Since O H must always be greater than O D, the change is always in the direction of augmentation, and we are therefore justified in thinking that such an arrangement might be beneficially employed in regulating the intensity of lamps; for though in the remote section the light suffers by the introduction of the condenser, there is upon the whole an augmentation of power at work.

The actual power in the two sections of the circuit will be $\frac{OE^2}{2r}$ in the generator's section, and $\frac{EC^2}{2R}$ in the remote section.

These, of course, when added together, are equal to the power of the source, *i.e.*, to $\frac{OC.OH}{2r}$, which any one can verify from the geometry of the figure.

It may be interesting to note, however, that we can exhibit the powers in the two circuits as the products of certain lines in the figure divided by the *same* denominator, so that they can be compared by the mere multiplication of measurements taken with a pair of dividers.

The power in the remote circuit is $\frac{EC^2}{2R}$; but E C : E F :: R : r, therefore $\frac{EC}{R}=\frac{EF}{r}$, and the power becomes $\frac{EC.EF}{2r}$ while that in the generator's circuit is $\frac{OE^2}{2r}$, and the total power is $\frac{OC.OH}{2r}$.

Therefore they can be compared with each other by measuring

$$EC.EF,\quad OE^2,\quad OC.OH.$$

Also, since C H : C E :: F E : D O. Therefore, C E . F E = C H . D O.

Therefore, the three powers are again as

$$CH.DO : OE^2 : OC.OH;$$

and we have only to divide by $2r$ to obtain the absolute powers.

(TO BE CONTINUED.)

THE MECHANICS OF ELECTROLYSIS.

BY A. BANDSEPT.

(CONCLUDED FROM PAGE 333.)

II.

In industrial electrolysis, the theoretical arrangement of the voltmeter has generally been abandoned. The arrival and departure of the current take place precisely at the places where the charges of the polarised elements accumulate. It is therefore not possible to obtain the complete exhaustion of the dissociated radicals; and a considerable portion of the gas escapes without producing any useful chemical effect. This difficulty is remedied by reversing the poles and by completely immersing the electrodes. The dissociated radicals are drawn along by convection to the top of the plates or wires and expand there. The grouping and accumulation at the polar surfaces are no longer interfered with by the vibration resulting from the passage of electricity. At the moment of their being set at liberty, the constituents of the liquid become subjected to two forces acting in opposite directions—one is the polar attraction, which projects the element towards the origin of the circuit; and the other, acting subsequently, is the convection, which directs the radical partially discharged towards the upper portion of the plate, where penetration is easier, and where the release takes place in consequence of a fresh condensation of the gas.

A few considerations as to the mechanism of electrolysis in these two cases will give an opportunity of estimating the importance of the results obtained by this modification in the working of the apparatus.

(A.) In the former system—ordinary arrangement with connections at the top of the electrodes—there are two cases to be considered, corresponding with the effects produced at different points of the acting surfaces and at the various stages of the work.

1. When decomposition takes place mainly at the surface of the liquid, the hydrogen, H, in arriving at the negative, is partially condensed at H_1, and gives up the energy which is absorbed by the polar substance. The elements which escape condensation are again transformed into gas, taking with them their own charges and the quantity of heat necessary for their formation into molecules H′. Sometimes, instead of the occlusion of hydrogen by the surface of the negative, combination takes place with one of the compounds of the latter; nevertheless, as there is always a question of condensation, the above explanation applies indifferently to the two kinds of action.

2. When, on the other hand, the reduction is specially active in the lower layers of the electrolyte, the phenomenon is complicated by a new effect, that of the absorption, in reduced proportion, of the charge itself given to the electrode by the work of polarisation. In fact, the elements $h\,h$ which escape condensation at H_1 encounter, in their upward move ment along the plates, a continually increasing resistance to penetration. This accession of reaction is due to increased potential of the plates and to the accumulation of the electric current at the point where it leaves the apparatus. The gases

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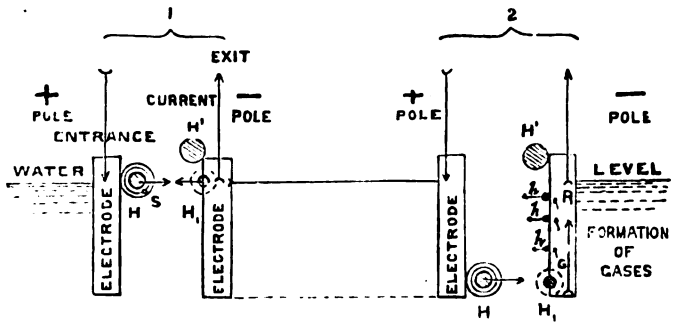
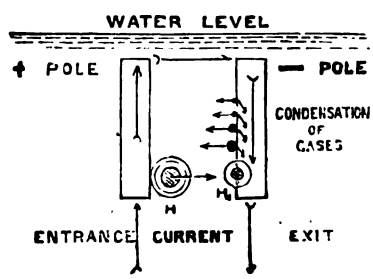
in rising, tend to put themselves in equilibrium with the differently charged zones which they traverse; they absorb energy for their progressive expansion and for their subsequent formation into molecules.

Diagram of the molecular actions of electrolysis according as the connections are made out of the water and at the upper part of the electrodes, or are arranged at the lower portion with complete immersion.



FIRST SYSTEM—ORDINARY CONNECTIONS AT THE TOP.

Maximum of re-action at R_1 by the accumulation of current and increase of potential of the plates. Formation of gases lost at G by absorption of energy.



SECOND SYSTEM—REVERSAL OF THE POLES OR CONNECTIONS. UNIQUE CASE.

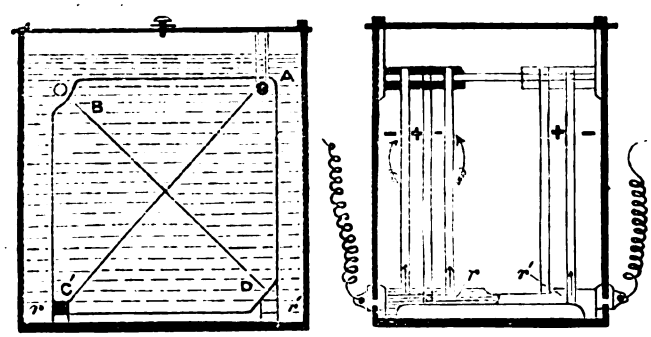
Minimum of resistance at r through the effect of aspiration due to the current and to the reduction of the reactive charges of the polarised plate. Condensation of the elements that have escaped at H_2, and recuperation of their energy.

(B). But when the poles or connections are reversed—that is to say, when the current is made to enter and pass out at the lower portion of the electrodes, the latter being entirely submerged, the loss of gas can no longer take place.

It will be remarked, in the first place, that during any given period of the charge, and at every degree thereof, the maximum of decomposition takes place in the lower layers of the system; the current arrives there with all its intensity, and yields to the dissociated radicals all the energy which they are capable of storing up. The effects of polarisation of the plates take place, therefore, at full pressure. A certain portion of the reducing element always escapes the condensation which takes place at H_1; but the gaseous bubbles *h h*, instead of expanding, as in the former system, become recondensed at the upper part of the electrodes; since the surfaces there are more permeable, on account of the reduction of the reacting polar charges and of the drawing-along action (*entraînement*) caused by the current. The gaseous elements are, therefore, completely exhausted by a mechanism analogous to that which occurs, during the expansion of steam, in compound engines. Just as, in these engines, the larger cylinder serves for the exhaust of the smaller, so here the upper portion of the plate serves to collect the motive power which the gaseous elements are still capable of exerting, no longer by their expansion, but by their condensation in a medium or chamber of lower pressure. By analogy, again, with what takes place in compound engines, in which the irregularity of the strains is much less than in a single-cylinder engine, a yield, or *régime* of discharge, more constant than that which is now supplied, is obtained from the new electrical arrangement. The influence due to the loss of gas is thus greatly diminished.

In electrical accumulators, the theoretical arrangement of the voltmeter has been abandoned, probably through want of combination which permits of putting in practice the method naturally indicated. It seems, in fact, more elementary to reunite the terminals of plates out of the water, as is generally done, and to place heavy masses of lead on the bracket at the bottom of the tanks. However, on examining matters more closely, it will readily be seen that the installation loses nothing of its simplicity when the problem of utilising the energies lost by the escape of the gases is approached. Not only is the solution practically possible, but it also leads to this immediate result, an effective reduction in the weight of the electrodes. It is not necessary, in fact, to provide the plates with two classes of terminals; the latter may, on the contrary, be entirely suppressed, and all the surface of the plates be made to participate in the electrolytic action.

Let A B C D, in the accompanying diagram of a battery, be a rectangular plate, suspended at A, the right hand upper corner, and resting at C, the opposite lower angle,



on a small rod of lead, *r*, which serves as connection. This rod is placed lengthways at the bottom of the bath, and sustains all the weight of the electrodes of the same name. By cutting off the angles B and D, it is possible, by turning the plates and arranging a system of suspension and support, symmetrical with the first, to arrange an electrolytic apparatus, presenting the maximum of useful surface for a given weight of electrodes of any given system. There is, in such a case, an increase of useful effect and also an increase of capacity for storage.

III.

An appreciable increase in the power of accumulators has lately been announced. It is evident that, at present, no limit can be assigned to the capacity for storage of a given weight of matter; it is not sufficient, in fact, to estimate the yield according to the fundamental law of equivalents, since no one knows exactly what the chemical reactions are which occur in the battery. Next, such a yield, however well it may be calculated, only answers to the special and relative conditions of the system under consideration, conditions which may be completely modified by physical influence. The nature of the electrodes exerts on electrolysis a chemical, a physical, and a mechanical influence. All three resolve themselves into penetration, the degree of which determines, in its turn, the power of absorption—that is to say, the power of utilising radical charges. They correspond with the effects due to the different orders of interstices of the electrodes—interstices atomic, molecular, and porous.

There is, therefore, ground for considering, in the first place, the kind of porosity which is most suitable for polarising surfaces; and, from this point of view, the natural or electrical formation is evidently the best, on account of the regularity and the fineness of the interstices, which permit of obtaining a more complete and more prolonged condensation than in the case of oxidised substances added to the plates. The work is coarser when the oxides of commerce are employed; and an electrode thus composed may be defined as constituting an increase, at every step, of the polar surface naturally formed, giving rise to another order of mechanical reactions.

The electrode is a centre of action, the influence of which decreases with the distance. The groupings, determining the combination or occlusion, become so much less perfect as the new elements are less directly turned towards the "attracting" body. It may be said that, in general, the deposit loses in quality what it gains in thickness. A filiform electrode is, therefore, the most perfect in theory, because, the more

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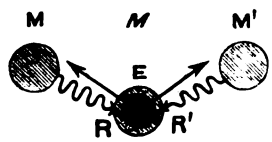
numerous the centres of action for a mass of matter which has a tendency to connect itself therewith, the better will the various groupings be established, and the better also will the *vis viva* of the dissociated elements be utilised. This consideration shows that the method of adding to the plates thick layers of matter is contrary to the principle which governs the polarisation of the *ions*.

As the reduction progresses partly in an inverse direction to the decomposing current, it follows that the combination of the radicals with the substance added does not take place at the origin of the motion—that is to say, at the centre of attraction, but simply in its neighbourhood, at a considerable distance, due regard being had to the minuteness of the molecular effects corresponding with the transformations. In a word, the charge of the radicals into each of the zones of the electrode is not completely utilised, since these radicals do not acquire all the speed of which they are capable.

To generalise. Under the supposition of an ideal electrolysis, it is a question of decomposing a molecule E into two others, M and M′, offering resistances $\pm R$ and $\pm R'$. It is evident that the energy stored up for this separation will include that which is necessary for the disorganisation of the grouping—affinity—of E in a medium *M*, in addition to that which must be expended for the penetration of the molecules M and M′. The energy set to work may therefore vary within very wide limits if the relative conditions of the system also vary. The more difficult the dissociation of the element



E in the medium M *M* M′, so much the more energy will it store up, which energy will be entirely restored under the conditions of the hypothesis. There will be no limit to this storing-up until the absolute capacity for motion of the substance be attained.

The reducing power of a radical of hydrogen in the nascent state, for instance, varies according to the reaction which has produced it. If the medium changes in which the combination is effected, it follows that, at the moment when the radical re-issues from the combination, it is accompanied by the whole quantity of heat generated during its release. Its formula, which was H *calories* (heat units) will become H + *n calories*; and the hydrogen will be so much more active as the value of *n* is greater.

There is, therefore, nothing impossible in the attempt to get a higher percentage of useful effect from an accumulator than that which has hitherto been accomplished.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 356.)

Compensation methods of a sort had been used before by Gerland and by Thomson. Gerland applied compensation to determine the E.M.F. of two metals dipped into a liquid, and Thomson applied it to the divided-ring experiment, thus making it very analogous to that of Pellat.†

Pellat also adopts Sir William Thomson's view that the Volta effect is due to a true contact-force between the metals, and that it represents a real difference of potential between them when in contact; at the same time he is careful to point out that no rigorous proof can be given of this, and that all that is really and certainly measured electrostatically is the difference of potential between what he calls the electric coats (*les couches électriques*), or what may be more simply called the air-films, on the two touching metals.

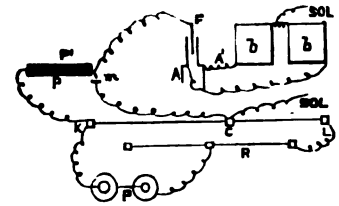


FIG. 6.—Diagram of Pellat's Method.

Légende.

KL, compensateur.
C, curseur.
R, rhéostat.
P, piles Daniell fournissant le courant du compensateur.
p′ p, plateaux du condensateur (*p* fixe, *p′* mobile).
m, interrupteur.
F, feuille d'or.
A et A′, plateaux attractifs de l'électroscope.
b b, batteries de 100 volts chacune pour charger les plateaux A A′.

The diagram, Fig. 6, pretty well explains itself. The contact at *m* is broken the instant before *p′* is raised.

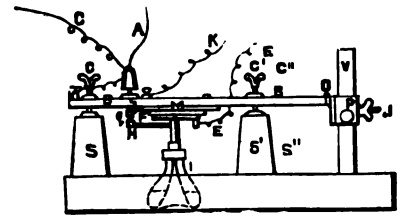


FIG. 7.—Pellat's Condenser.

Fig. 7 shows how this was done in practice. Pulling the string, A, raises a sliding-pin with a shoulder, *q*, fixed to it a millimetre below the bar, B. The pin thus first breaks contact near H, and then raises the hinged bar B B, to which the upper plate, M, is attached. The upper plate, being always in connection with a battery, requires no special insulation. The lower plate is carefully supported by a Thomson insulator, I. The lower plate was considerably smaller than the upper one, and it was further protected from stray inductions by a guard-screen. Screws, *c c*, served to regulate the distance between the plates.

The following is a summary of some of Pellat's measurements, gold being the metal with which all are compared, and the numbers being given in volts.

"*Difference of Potential of the Electric Coats which cover a Metal and Standard Gold metallically connected, and both in Air.*"

Metals used.	E.M.F. in volts. With very clean but scarcely scratched surface.	E.M.F. in volts. With surface strongly scratched by rubbing with emery.	Metals used.	E.M.F. in volts. With very clean but scarcely scratched surface.	E.M.F. in volts. With surface strongly scratched by rubbing with emery, or in some of the last cases with cloth or filter-paper.
Zinc	·85	1·08	Iron	·29	·38
Lead	·70	·77	Brass	·29	·37
Tin	·60	·73	Copper ...	·14	·22
Antimony	·44	·49	Platinum.	- ·03	+ ·06
Nickel ...	·38	·45	Gold	- ·04	+ ·07
Bismuth..	·36	·48	Silver ...	- ·06	+ ·04
Steel	·29	·44			

4. Meanwhile some experimenters, starting with a belief in the chemical origin of the Volta effect, had made experiments supposed to support this view. Mr. J. Brown, of Belfast, in 1878, repeated Thomson's divided-ring experiment,* as well as Kohlrausch's condenser experiment, in other gases than air; and found a very decided difference, and even a reversal of sign, when sulphuretted dydrogen was substituted for air. The metals Brown used were copper and iron, and he obtained a 1-centimetre deflec-

* Reprinted from the *Phil. Mag.* for March.

† I find, indeed, that Sir W. Thomson completely anticipated Pellat in the application of galvanic compensation to the measurement of Volta effects; for in *Nature*, April 14, 1881 (vol. xxiii., p. 567), is printed an account, given in brief at the Swansea meeting of the British Association (see Trans. of Sects., 1880, p. 494), which relates how the divided-ring experiment naturally developed into more complete compensation with slide resistances, and that an extensive series of measurements were made on this plan in the years 1859-61 with results quite in agreement with those published by Hankel in 1862. Other experiments were made since 1861 with results confirmatory of those of Pfaff, 1821, showing the Volta effect to be independent of the surrounding gas. The description of all these experiments was therefore withheld till something new should be obtained by the method, and was not published until Pellat's paper had appeared in the *Journal de Physique*, May 1880. Fig. 10 sufficiently exhibits Sir William's arrangement. In a postscript are described a few additional experiments of the same kind as those published in 1881 by Schulze-Berge, in which a platinum plate is soaked for a certain time in dry oxygen or oxygen, and then used in the Volta condenser. The observation is made that merely soaking a plate in gas is more effective than electroplating it with the same gas with an E.M.F. of a volt.

* J. Brown, Phil. Mag. August 1878, Feb. 1879, and March 1881; see also Brit. Assoc. Trans. of Sect. 1881, and 'Electrician,' vol. vii. p. 165.

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tion in the direction indicating iron + in air; while in SH_2 he obtained a a 3-centimetre deflection, indicating that iron was —. On readmitting air the deflection again reversed, and so on until the copper coated itself with a blue film of sulphide, when the deflection became undecided, owing, as Brown supposes, to "the cessation of chemical action."

In 1881 he observed a time-change (decrease) of the Volta effect at a copper-zinc junction, and reckoned that at the first instant after cleaning the potential difference would he as high as ·9 Daniell, "which," he says, "agrees with J. Thomsen's determination of the difference of the heats of combustion of zinc and copper and oxygen." He here gives a hint of holding a heterodox notion which I do not find in any other of his writings, and which I believe he abandoned, even if he ever really held it.

In 1879 Brown tried a copper-nickel divided ring, substituting HCl for air, and here also succeeded in obtaining a reversal of sign. He also arranged a divided ring of wet blotting-paper, and showed that there was a difference of potential when the two halves were touched with a zinc-copper couple (which is not remarkable); but he then goes on to draw a moral, and to say that the slit of the divided ring corresponds to the air-film, and the wet paper to the moisture film in the ordinary Volta-condenser experiment. The film of moisture on the zinc plate is thus shown to have a + charge, and that on the copper a negative. If it be objected that the better the plates fit, the better the manifestation of contact E, it is to be replied that it is not to be supposed that there is no air between them anyhow (says Brown). Probably, he says, gas produces the difference of potential only so far as it forms a film on the surface. When a metal and a liquid are experimented on, it is probably really a two-fluid cell, the other fluid being that condensed on the surface of the metal.

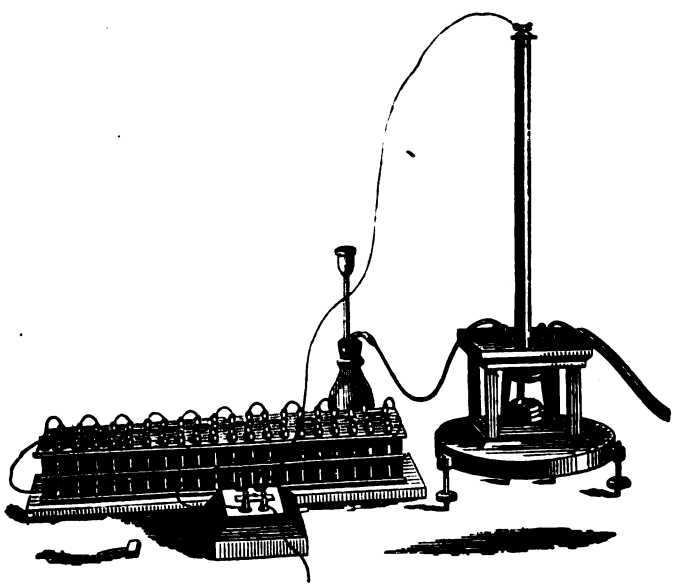

Fig. 8.—Mr. J. Brown's Arrangement for observing the Volta Effect in different Gases by Sir William Thomson's Method of a bimetallic ring with an electrified needle hanging over it.

Brown thus goes strongly for the activity of the films, or condensed air-sheets, which certainly exist on the surface of solids, and which may play an important part in the matter; but he supposes that these films act by corroding or attacking the plates, and that such a film is necessarily existent between surfaces nominally in contact if any Volta effect is to be produced; so that if the metal faces really and truly touched all over, they would show no charge when separated. Moreover, he lays it down that the potential difference is only observed while chemical action is going on; but that so soon as it ceases, from any cause, at once the Volta effect ceases too. In all this I entirely differ from him; but his experiments are very interesting and much to the point.

They cannot, however, be regarded as settling the question—the very important and fundamental question—as to whether the Volta effect depends on the atmosphere or medium surrounding the plates, or whether it is an absolute effect depending on contact alone. Experiments on this point are absolutely discordant; and it seems to be one of those points which it is very difficult to settle by direct experiment. For if by using a chemically active gas instead of air, you get a positive result or change in the Volta effect, the answer from the other side is "Yes, of course, because your plates are corroded and coated with sulphide or chloride, or something whose contact-forces come in and modify everything." If, on the other hand, you get a negative result when you substitute some inert gas like hydrogen for air, then it is objected that you have not removed the air-film which the plates had contracted from long standing in the air; and if you answer indignantly that you did, and that your hydrogen was perfectly pure, it is replied with a sneer, "Oh, yes, it is not so easy to get pure hydrogen as you seem to think."

Moreover, suppose a positive effect on changing the gas *was* established; what then? Nothing is settled except that the metal/air contact-force is proved to be somewhat different from the metal/gas contact-force. There seems to be really no way of knocking contact-force on the head experimentally, and this probably because it is a reality: *there really is* a contact-force at every junction of dissimilar substances; and the E.M.F. of a circuit, whether it be inductive or conductive, is always the sum of such contact-forces. I do not say that the contact-force at any given locality has the value ordinarily assigned to it as the result of experiment.

The earliest attempt made to examine the question as to whether the Volta effect depended on the atmosphere was made by Pfaff* in 1829, who used dry and damp air, oxygen, nitrogen, hydrogen, carburetted hydrogen, and carbonic acid, and he found that there was no difference so long as no visible chemical action occurred; but it must be noted that the opposing faces of his plates were varnished. De la Rive, on the other hand, asserted that there was no Volta effect in the slightly rarefied air then known as "vacuum."

In recent times Pellat has investigated the subject, and has come to a conclusion in agreement with Pfaff, viz., that the differences are very small. The metals used by Pellat were copper and zinc, and the gases were air dry and damp, dry oxygen, dry nitrogen, dry and pure hydrogen, dry and pure carbonic acid. He finds slight variations, but exceedingly slight, and such as Pfaff, Exner, and Brown could hardly have detected. He says:—"Au surplus il est fort probable que, si quelques-uns des auteurs précédents avaient tenté les expériences que j'ai faites au sujet des gaz, ils auraient trouvé des résultats négatifs; les faibles variations produites par le changement des propriétés du gaz que j'ai pu mettre nettement en évidence, grâce à la précision des mesures, sont au-dessous des erreurs expérimentales de leurs méthodes, ou à peine supérieures dans les cas les plus favorables."

In all the above gases he has also studied the effect of varying the pressure. Lowering the pressure slightly *increases* the observed difference of potential; but the change lags a little behind the pressure-variation. Damp and dry air behave in the same way. In oxygen the effects of pressure are rather better marked. Nitrogen gives nearly the same numbers as air; but after it has been in for some time, the numbers are slightly lower than at first. Hydrogen gives a little greater effect than even rarefied air; rarefying hydrogen does not alter it much. Carbonic acid gives the same numbers as rare air or dense hydrogen. As for liquids, plates wetted with alcohol give the same result as if immersed in plain air.

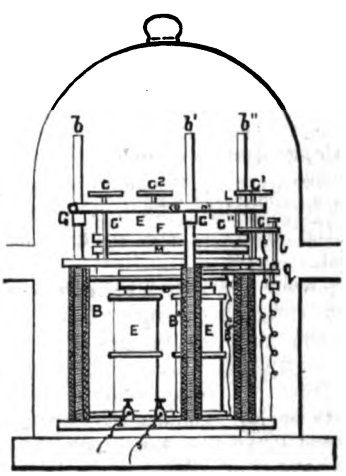

Fig. 9.—Pellat's Apparatus for experimenting in different Gases and a different Pressures.

The movable plate is now the lower one, and it is pulled down by an electro-magnet, E, a little way against the springs, B, which tend to drive it up against the screw tops, C. Contact is automatically broken at *q* the instant before separation. The bell-jar has 35 litres capacity, the diameter of each plate being 15 centimetres. It must be impossible to employ anything like pure gases in a bell-jar enclosing such a bulky mass of heterogeneous material; and the pressure was found not to go below 2 or 3 centimetres of mercury. However, he has since made a smaller arrangement of 1 litre capacity, with plates 9 centimetres diameter, and, what is more important, with the electro-magnet outside, and nothing inside but glass, mica, and metal. In this the pressure goes down to a millimetre. But even this is not all that could be wished. Moreover, the experiments described had been made with the larger apparatus.

Von Zahn† also tried a condenser in various gases, and found no difference; but when he tried a platinum-zinc condenser in the highly rarefied air now known as vacuum with some melted sodium in a branch tube to absorb all the oxygen, the Volta effect was diminished, and only represented a potential difference of half a Daniell. I am not clear whether sodium can be trusted to ultimately absorb every trace of oxygen; but I should judge it would take a very long time: and as to rarefaction, dividing the numbers of molecules in a vessel by a million or two leaves them quite numerous enough to accomplish anything they want.

Sir W. Thomson has also made experiments in different gases with negative results.‡ These experiments are not described in detail, but they were made with the apparatus shown in Fig. 10.

* Pfaff, *Ann. de Chim.* 2 ser. xli., p. 236. The metals he employed were copper, tin, and zinc.

† Memoir quoted subsequently.

‡ Thomson, Brit. Asso., Trans. of Sect., Swansea (1880), p. 494.

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The views of Ayrton and Perry on the subject of the effects of atmosphere underwent modification between their first paper and their third. In their first paper they say they have good reason to believe that there is no great difference of potential between a metallic or liquid surface and the air in contact with it.

Clerk Maxwell, in a letter to *The Electrician*,* pokes fun at them for this, saying:—"A statement like this, coming from men whose scientific energy is threatening to displace the centre of electrical development, and to carry it quite out of Europe and America to a point much nearer Japan, is worthy of all attention, even without an explicit statement of their 'good reason.' But Mr. J. Brown has shown (*Phil. Mag.*, August, 1878) by the divided ring-method of Sir W. Thomson, that whereas copper is negative with respect to iron in air, it is positive with respect to iron in H_2S. It would appear, therefore, that the reason why the results of metals by the ordinary 'contact-force' experiments harmonise so well with the comparison by dipping both metals in water or an oxidising electrolyte, is not because the E.M.F. between a metal and a gas or an electrolyte is small, but because the properties of air agree to a certain extent with those of ordinary electrolytes. For if the active component of the electrolyte is sulphur, the results are quite different; and the same kind of difference occurs when hydrogen sulphide is substituted for air."

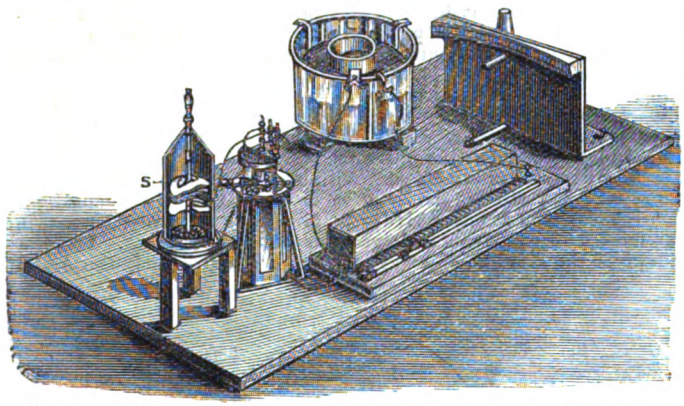

Fig. 10.—Sir William Thomson's Compensation arrangement for measuring Volta force in air and gases by a null method, devised and used in 1859, published in 1880.

The upper plate of the condenser is uninsulated, and slides up and down from one-fiftieth to a quarter or half an inch from the lower insulated plate, which is permanently joined to the electrometer. The upper plate is put in communication with the lower one momentarily through the slide resistance, and is then raised, the position of the slide being adjusted till no deflection ensues.

In their third paper,† therefore, we find Ayrton and Perry's views changed, and they clearly state that their experiments, like all those based on inductive methods, leave the question of air contacts quite undecided.

They then go on to say:—"One way of determining the E.M.F. of contact in volts between a substance and air, and a way we hope shortly to employ, is to repeat all these exact contact experiments in different gases [it is not quite true that this would give the results required, because it would only give differential effects; very important to observe, no doubt, but not the same as observing the actual contact force of air or of gas]. . . . . We shall thus ascertain whether the contact difference of potentials of a substance and a gas differs much for different gases. Qualitative experiments in this direction have already been made with very interesting results by Mr. Brown of Belfast, but his experiments differ from ours in not being quantitative." [Only, as their experiments do not yet exist, Mr. Brown's have still some value.]

In vol. xii. of Wiedemann's *Annalen*‡ I find some interesting experiments by Schulze-Berge on contact-force between metals and gases. He uses a condenser and different gases, but the plates of his condenser are both of the same metal, and he coats one of the plates with a film of the gas, say chlorine, or hydrogen, or ozone, and leaves the other covered with air. To measure the potential difference he employs the compensation method of Pellat, and his arrangement seems fairly satisfactory. But he does not explicitly enter on the question as to the seat of E.M.F. in the Volta experiment (except in a controversy with Professer Exner). He assumes that a contract force between metals and metals and between metals and liquids has been established, and he wishes to extend it to the contact of a metal and a gas. Believing firmly in the existence of films of condensed gas at the surface of a solid, which films require time for their formation or removal, he deems it sufficient to soak one of the plates of his condenser in the gas to be examined, and then to take it out and measure the difference of potential between it and the other plate coated only with a film of air. Tried thus, ozone rendered gold, platinum, and brass negative as against the corresponding air-covered plate. Hydrogen rendered its platinum strongly positive; but its influence on gold was slight, and on brass uncertain. Chlorine and bromine made platinum negative, and ammonia made brass positive.

(TO BE CONTINUED.)

* *The Electrician*, April 26, 1879. † Phil. Trans. 1880.

‡ Schulze-Berge, "Ueber die Elektricitätserregung beim Contact von Metallen und Gasen," *Ann. der Phys. u. Chem.* xii. p. 293 (1881).

PHILADELPHIA EXHIBITION.

(CONTINUED FROM PAGE 337.)

THE ELECTRIC TUBE COMPANY.—UNDERGROUND CONDUCTORS.

The essential form of the conductors exhibited by this company is that of an iron tube containing one or more copper conductors insulated from each other and the enclosing iron tube, and having all remaining spaces in the latter filled with an extremely viscous, almost solid, insulating compound, which becomes fluid at a high temperature. This manufactured product is termed an "electric tube." These tubes are manufactured in fixed lengths, generally 20ft. The conductors project from 2in. to 3in. beyond the end of the enclosing iron tube, and two lengths of electric tube are joined together by means of copper joints soldered to the projecting conductors and so formed as to allow the expansion of the conductors to take place without injury or danger. Such joints are protected by a cast-iron box completely enclosing them and securely fastened to the ends of the tubes enclosing the conductors. This box is then filled with the same compound as the tube and hermetically sealed.

The exhibit of this company showed the great range in the size and number of conductors which the fundamental form of cased conductor permits, and the great flexibility in making circuits of complicated ramifications, which is given by the plan of having joints at frequent intervals, and the methods of making these joints.

To illustrate the range in size, &c., samples of electric tubes were shown containing conductors varying in number and size, from a single round conductor 1·61in. diameter, of 2,592,100 circular mils. or 2·036 square inches sectional area, in an iron tube 2⅞in. outside diameter, to 271 wires No. 14 Brown and Sharpe gauge, of 4,100 circular mils. or ·00322 square inch sectional area, in an iron pipe 3¼in. outside diameter.

To show the manner in which circuits of a complicated character may be made with this form of conductor, circuits such as those used for incandescent lighting on a large scale, having a large number of derived circuits with conductors of widely differing sizes, there was exhibited a portion of an underground circuit such as is used in T. A. Edison's 3-conductor system of incandescent lighting—a system using tubes of which the cross section is shown by Fig. 1.

This exhibit consisted of—first, a "junction safety catch box." This is a large round box, the top of which is flush with the surface of the street. It is provided with a loose outside cover, and a lighter inside cover bolted down to make a water-tight joint with the box; these being removed, disclose the internal electrical connections in a readily accessible position, six inches below the surface of the street. The central portion of the box is occupied by the "pole pieces," consisting of as many rings as there are conductors in the system (in this instance three), each ring having as many radial projections as there are tubes entering the box (in this instance six). These projections, which are symmetrically arranged as regards polarity, are all brought to the same level at their extremities, and terminate in plane, polished, gold-plated surfaces one inch square, which are arranged equidistant from each other in a circle around the centre of the box. Each of these surfaces has a tapped hole in the centre.

FIG. 1.

In a circle outside the pole pieces are as many "safety catch joints" as there are conductors entering the box (in this instance 18). These safety catch joints are arranged radially opposite the extremities of the projection of the pole pieces; each consists of a copper or composition piece which has a copper rod soldered into it projecting about eight inches downwards into the body of the box, the upper end of the composition or copper piece terminating in a plane, inch-square, gold-plated surface, the same as those on the pole pieces. These surfaces of the safety catch joints are on the same level as the similar surfaces on the pole pieces, and radially opposite and equidistant from them.

Two feet below the top of the box (that is the surface of the ground) the electric tubes (in this instance 7) enter the box and are rigidly attached to it, the joint being made water-tight. The pole pieces and the safety catch joints are all insulated from each other, but rigidly attached to a support rising in the centre from the bottom of the box.

Flexible copper cables join each conductor of each tube with one of the copper rods, which project downwards from the safety catch joints, so that by means of flat safety catches placed across from the safety catch joints to the corresponding projections of the pole pieces, all conductors of like polarity are joined together at this point with a safety catch in each circuit in a readily accessible position, where it can easily be removed or replaced. Such a box equalises the electromotive force at that point of all lines entering it, or if one of the tubes is a feeder—that is, runs back to the dynamos—the box is a distributing point for several circuits, which may or may not be brought together again at some other place.

The conductors in the tubes entering this box may be of any size to suit the requirements of the different circuits. The circuits shown entering this box vary from 350,000 circular mils. to 133,000 circular mils. area of conductor, and are arranged to show how they may be laid, bent in different degrees to right or left, joining each other at their extremities, crossing each other and joined together at the crossing, joining other circuits at any point in the length of the latter, reduced in size at any point of their own lengths, and having derived circuits of any size taken from them at any point of their own lengths, and having all these varied connections of different sized conductors

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made by means of a comparatively small number of standard patterns of connecting joints, boxes covering the joints, and ball clamps attaching the boxes to the iron tube enclosing the conductors.

The ball clamps, in connection with the boxes, are essential features of all underground conductors of this company's exhibit.

Figs. 2, 3, and 4* illustrate the forms of these parts and the manner in which they are used.

Fig. 2 shows the top and bottom halves of a "coupling box," a 3-conductor system, and Fig. 3 a "ball lamp," whilst Fig. 4 shows the bottom half of the same coupling box with tubes and ball clamps in place and joints connected. The two parts of the ball clamp being bolted together on the tube are thus securely clamped to it, the hemispherical parts come together to make a sphere which fits the spherical socket in the nozzle of the box; the two together thus form a ball and socket joint, allowing free angular movement of the tube in any direction, but preventing longitudinal movement of the box on the tube. The angular movement allowed by the ball and socket is limited to any amount in any direction by providing a rib inside the box (either separate as in Fig. 11, or forming the inside opening of the ball-socket of the box, as in Fig. 2) of such a form, that when the extreme amount of angular movement to be allowed in any one direction is obtained, the tube projecting into the box through the ball clamp comes in contact with this rib, thus stopping any further movement in this direction.

The box is made of such size and form, that when the tubes have the extreme angular movement allowed there is still ample space between the joint and the box to prevent the two coming in contact. Rotary movement of the box on the tube is prevented by means of the small lug on the ball of the clamp, which loosely fits sidewise, the slot shown in the socket of the box, the slot being sufficiently elongated lengthwise that the lug may have free play in that direction within the limit of angular deviation allowed.

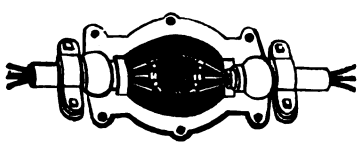

Fig. 4.

The limiting rib inside the box is made to give the angular movement allowed when the largest size of iron tube that will go into the box is used, but any smaller iron tube may be used in this box (as, for example, in reducing the size of the conductor at this point) by means of a ball clamp, of the form shown in Fig. 5, with a ball to fit the box, but with a smaller semi-cylindrical groove in each half to fit the smaller iron tube. This clamp has in addition, as shown, a semi-cylindrical ring concentric with the groove cast on the ball of each half, the two, when the two halves are clamped together on the iron pipe, forming a cylinder projecting into the box, of the same outside diameter as the largest iron tube that will go into the box. This projection on the clamp striking against the limiting rib inside the box limits the angular movement of the smaller iron tube to the same amount as when the largest size of iron tube that will go in the box is used. Therefore the ball clamp and box, as described, whilst making the iron envelope of the conductors mechanically continuous, and preventing rotary movement of the boxes on the tube, allow an angular deviation (in this case 1 in 10) in every direction, at each end of every box, which gives a degree of flexibility to the whole line (in this instance 11½ degrees at each joint), and at the same time renders it impossible that the joint should touch the box, with the extreme amount of angular deviation allowed. The ball clamp, modified as shown in Fig. 5, also permits the use in any box of any tube smaller than the largest that will go in the box, whilst preserving the same limit of angular movement.

Fig. 6.

The flexibility of the whole line thus obtained is necessary for rapid and cheap laying in streets, where, from the number of gas, water, and other pipes, sewer manholes, &c., it is impossible to run tubes in a straight line for any distance.

The joints for 3-conductor tubes consist of pieces of copper wire rope, having cast or brazed on their ends suitably shaped composition sockets, in which are drilled holes to fit the size of copper conductor for which they are intended, and to which they are soldered in laying the line. The joints necessary to obtain the results illustrated by the exhibit are: "coupling joints," for connecting two tubes in a straight line (Fig. 6 shows the form of one piece, three such pieces being used for a complete joint), "90° elbow joints," for bending 90° to right or left, and "45° elbow joints," for bending 45° to right or left. Fig. 7 shows three forms of pieces, different combinations of which will make all kinds of elbow joints—"branch joints," by which to any coupling joint in a line of any sized electric tube may be attached a branch to one side, or one to each side, of any sizes not larger than the main line. Branches of sizes larger than the main line, being of rare occurrence, are not allowed for in the standard patterns for branches enumerated below, but, when required, may be made by a slight modification of the latter. Fig. 8 shows three forms of pieces, different combinations of which will make, to either or both sides of any coupling joint, branches of all sizes ordinarily required; a few of the largest sized branches require special patterns of modified forms, which are enumerated below. The form of socket of the coupling joint shown in Fig. 6 gives the copper wire rope of the joint a bowed form when the joint is in place, to allow for the expansion of the conductors in each electric tube. The form of the joint when in place is seen in Fig. 2. Fig. 6 shows that, in addition to the hole which fits the conductor, each coupling joint socket has another hole drilled in it; the male sockets on the ends of the branch joint pieces (see Fig. 8) fit these holes and are soldered in them in attaching a branch joint; the female sockets on the other ends of the branch joint pieces are drilled to fit the conductors of the electric tube used for the branch lines. Fig. 9 shows a coupling joint with a branch joint attached, in the bottom half of the box used for covering this kind of joint.

The 3-conductor system, so far as it is exhibited, has 21 different sizes of electric tubes, having conductors varying from 500,000 to 27,000 circular miles sectional area. The enclosing iron tubes are of 5 different sizes, varying from 2⅜in. to 1 1-16in. outside diamater. All connections are made with 10 patterns of boxes, 8 patterns of ball clamps, and patterns of 43 pieces for all joints. Of the latter, 6 patterns are required for coupling joints for all sizes, 3 of these patterns are also used for elbow joints, which require 15 patterns in addition, making 21 patterns for all varieties of all sizes of coupling and elbow joints. The remaining 22 patterns are for branch joints, and 12 of these will make any combination ordinarily required, the other 10 being for use in cases which rarely occur.

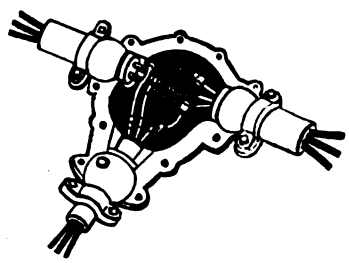

Fig. 9.

Electric tubes are exhibited cut away to show the internal construction, which consists in wrapping each copper conductor with a layer of insulating tape, and winding each taped conductor spirally with rope impregnated with insulation. The pitch of this winding is large compared with the diameters of the rope used, so that the windings of the several conductors fit between each other when the conductors are placed together. As many conductors as are to go in one tube, being so placed together, they are bound together by a final spiral winding of rope around them all, and the bundle of conductors thus formed being introduced into an iron tube, the process of manufacture is completed by filling the tube with insulating compound liquid, at high temperature, ready access being afforded the latter throughout the length of the tube along the spiral paths formed by the rope-winding of the conductors.

Another variety of electric tube is illustrated by an exhibit of a complete set of sample tubes for the 2-conductor system of incandescent lighting, and typical examples of the boxes, ball clamps, and joints used with them. The conductors in this system vary from 1,639,890 circular mills., or 1·2879 square inches, sectional area in a tube 3½in. outside diameter, to 33,015 circular mills., or 0·02593 square inches sectional area in a tube 1 1-16in. outside diameter, and, there being only two in a

Fig. 10.

tube, economy of space in the latter is secured by making the conductors in the form of segments of circles, as seen in Fig. 10, which shows a cross section of one of these tubes. The joints for these tubes are of cast copper, the allowance at coupling joints for expansion of the conductors being given by making the joints with a U-shaped bend, projecting at right angles to the line of the tube, the section of the joint in the U being flattened to a parallelogram, long in comparison with its width, as is seen in Fig. 11, which shows a coupling joint for this system of tubes, with bottom half of coupling box. Holes are bored in all joints of the same form as the conductors for which they are intended, and to which they are soldered in laying. Boxes are exhibited with short tubes entering them, and joints connecting the latter, showing the forms assumed by different sizes and varieties of coupling elbow and branch, joints and boxes. Fig. 12 shows one variety of one size of 90° elbow joint, with bottom half of elbow box.

In both the 3 and 2 conductor systems, boxes and joints are shown for use in in-door lines of these tubes. The flexibility of the line which is required for underground work, and which is given by the ball and socket connection of clamps and boxes, is not necessary in in-door lines; the boxes may therefore be smaller on this account, and also on account of the absence of the ball clamps, the mechanical continuity of the iron envelope of the conductors being secured in small space

* We have not thought it necessary to show all the figures. Those shown give all requisite details.

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by means of a ring which is screwed on the threaded end of the iron pipe and fits in a groove cast in the neck of the box (which neck fits the iron tube). This box is made in halves, which are bolted together over the joint, the end of the tube, and the ring screwed on the latter.

Underground arc light circuits were illustrated by two exhibits showing the character of the tubes and joints and the method of taking loops to lamps. One showed tubes with two round conductors for a complete circuit in one tube.

Fig. 13 shows this exhibit, and the method of making the joint so that, the branch tube being led off to a lamp or lamps, the two conductors of the branch form a loop of the main line. The second exhibit shows the case of a circuit completed by a line on another street. In this exhibit the main line tubes entering the box have only one conductor each, the conductor of each tube being joined to one of two conductors of the third tube, forming a loop from the main line of a single conductor. The joints are of wire rope of the same character as the joints for the 3-conductor system. Ball clamps are used to connect tubes with boxes.

A distinct variety of electric tube is that designed for telegraphic and telephonic use. In this case, the conductors being large in number and small in size, instead of the spiral rope winding round each conductor, the insulating covering is continuous, and a rope winding is only used round the outside of a bundle of such wires. The wires are laid together regularly, on the basis of a hexagonal cross section for the bundle, and at each end are threaded through wooden screens which have holes drilled in them, in the same relative positions as the wires occupy in the tube. At one end of each tube, before being threaded through the screens, the wires are woven together so as to change the relative positions of the wires. This operation of weaving is simple and systematic, and the same for all tubes with the same number of wires, and is arranged on such a basis that, in conjunction with a systematic rotation of consecutive tubes, alternately to right and left, in the process of laying, it produces, in a series of long period, methodical changes in the relative positions of the wires in consecutive tubes, for the purpose of neutralising the effects of induction. In making the joints of these tubes, wires threaded through corresponding holes in the screens are bent outwards and placed together in the same notch of a series of notched wooden slats, one for each layer of wires in the joint, which are built up one above the other, as the process of making the joint proceeds. When all the wires are so bent out, the ends are clipped off, leaving about one inch projecting through the wall of notched slats; the insulation is then slipped off the ends, and each pair joined by a small sleeve, which is soldered to them to make the joint. In general, the joints of half the

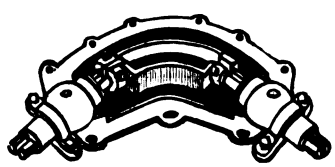

FIG. 12.

wires are made on one side and half on the other side of the box. Grooves are provided in the boxes, into which they fit the wooden screens through which the wires are threaded, and the series of wooden slats built up in making the joint, holding these securely in place. By this method of making the joints, every joint of every wire, at intervals of 20 feet, is brought into a position in which it is readily accessible for purposes of testing, making connections, &c., without interfering with any other wire, so that at any such joint, loops, or single service wires may be attached to any or all of the wires in the line. A line of this character, containing thirty-seven wires, was exhibited, with several consecutive boxes and joints to show the system of weaving wires in conjunction with alternate rotation of tubes. Such a line is adapted more particularly to telegraphic uses. Another box was exhibited, constructed with especial reference to the needs of telephone service, for which, in addition to trunk lines between stations, a number of wires are required for services in each block, and only run from the station to that block, thus giving a line between two stations a size decreasing gradually from each station to some point between them. The box exhibited, which showed a joint in a line of 217 wires, had a low turret rising from its upper half; the top of this turret was closed by a loose outside cover and an inside cover bolted down, and making a tight joint with the box by means of a rubber gasket, the whole being made water tight by filling the space between the two covers with the insulating compound. In every such box, along the face of a block, all those wires which are intended for use as services in that block are bent upwards instead of outwards in making the joint, so that the joints of all such wires project upwards into the turret and are held in position by a wooden frame shown, whilst the joints of all other wires are made out to the sides at a lower level. This arrangement allows the box to be filled with insulating compound, covering all the wires and all joints, except the joints of those wires intended for use in that block, which latter joints project up above the surface of the compound, and on removing the cover of the turret are all immediately accessible at every box along the block, for attachment of services, to any or all of them. Tapped holes are provided around the turret on the level of the joints of service wires, into which service tubes may be screwed, if electric tubes are used, or brass nipples to which are soldered the lead covering, if lead-covered wires are used for service connections.

This company also exhibits specimens of lead-covered wires of small sizes, and a specimen of flexible heavy conductor for indoor use, with large currents consisting of copper wire rope, taped, wound and lead covered. They also exhibit specimens of insulating tape, in rolls of 125 feet, continuous length, varying in width from 6 inches to ¼ inch, and jars of the insulating compound used in the tubes and boxes.

Comments by the Examiners.

This system may be summed up as belonging to division "A a" of the section's arrangement, or that in which the electrodes are permanently sealed. When any portion of an electrode is destroyed a new one is not introduced, but a new length of pipe is substituted, containing the necessary number of wires and attached at its extremities. The details are very fully given, and with the cuts render it unnecessary to repeat them. With a large stock of lengths and boxes and with trained workmen, the work of laying the conductors only a few inches below the surface of the streets would be comparatively rapid. While in the tentative stage of underground service this does not present the same amount of convenience as a system where wires may be introduced and removed at will; and presents the objection common to all "section" systems that the conducting capacity of the whole line is that of the most imperfect of splices made every 20ft., yet it answers the demands upon it much better than those systems which require expensive and tedious derangements of the street in order to accomplish repairs. The seat of an accident to one of the wires of this system is located from the central office, on and between known streets. The manhole is opened and the safety catches first of all examined. Managers assert that the place of the break can then be so accurately located that the length containing it (usually about 20ft.) may be at once removed and replaced by another.

The telephone and telegraph, and the light and power wires are not enclosed in the same tube. The insulating material with which the boxes are filled is still flexible at 32° F., but brittle at 0° F.

The method of laying and tapping for private dwellings would seem to afford complete protection against lightning. The three-wire system which has been grafted upon the Edison conduit system effects a saving of 62 per cent. on that required for the two-conductor system in the copper necessary for conductors.

The light and power system are not adapted for use by various companies, independently, though the telephone and telegraph conduits might be so applied.

The details of this system have been so perfectly elaborated, that in view of the fact that no complete description of it has been heretofore made public, the examiners deemed the above full report desirable.

(TO BE CONTINUED.)

ON CONSTANT ELECTROMOTIVE FORCE IN AN ELECTRIC LIGHT CIRCUIT.*

BY SIR DAVID SALOMONS, BART., MEMBER.

Although a considerable proportion of this paper is theoretical, yet abundant experiments were made before coming to any conclusions, and it is hoped that the result is not entirely without a successful issue.

Let the following points be assumed:—

(*a*) That the resistance of the leads be considered as *nil*, unless mentioned otherwise.

(*b*) That in all cases we are dealing with an incandescent light installation.

(*c*) That in all cases simple shunt dynamos are used.

(*d*) That the engines and dynamos employed are of ample size.

(*e*) That the accumulator is connected up in "parallel."

Now, for an increased resistance r in any circuit, that the current ($= C$) shall remain unchanged, and increased E.M.F. ($= e$) must be added, and if the original E.M.F. $= E$, and the original resistance $= R$, then

$$\frac{e}{r} = \frac{E}{R} \text{ and } \frac{E}{R} = C \therefore e = C r.$$

Hence, the E.M.F. must always increase by a numerical value which equals the added resistance in ohms multiplied by the original current in amperes. Further,

$$r = \frac{e}{C} = C^{-1} e,$$

that is, if the E.M.F. vary, then to keep C constant, the added resistance must equal $C^{-1} e$ (numerical value) ohms.

The reasons why the lamps in any installation are not usually steady are—firstly, that the motive power is irregular, or, in other words, the E.M.F. varies; secondly, the resistance of the circuit may vary and the dynamo not be capable of giving the required E.M.F. for all values of the current taken off; thirdly, a combination of both may exist.

It is seen that if the relations $e = C r$ and $r = C^{-1} e$ can be made to exist, the light will be perfectly steady.

In practice there is no convenient way of carrying out directly these relations, but the following are five methods of keeping the E.M.F. at the

* Paper read before the Society of Telegraph Engineers and Electricians, March 12, 1885.

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lamps constant, or nearly so :—(1) By a regular motor ; (2) by the use of accumulators working alone ; (3) by the use of accumulators placed parallel in the circuit whilst the dynamo is running ; (4) by placing in parallel any counter E.M.F. ; (5) by various automatic means, magnetic and otherwise.

Method (1) can only be obtained under certain conditions which will not here be dealt with ; method (2) is practically perfect ; (3) is approximate, and will be the one now to be investigated ; (4) is a new method, to be described ; (5) will not be considered in this paper. Installations at 100 volts are in very general use, in which cases 50 cells of an accumulator are required at a time (if E.P.S. cells are used), each cell giving about two volts, and the resistance of all the cells equal approximately one-tenth of an ohm. In general it is found that the best charging current, not to injure the cells, is that which has an E.M.F. 10 per cent. higher than that of cells to be charged.* Hence, with an installation as above mentioned, 10 volts will be the margin, and we get $C = \frac{10}{0{\cdot}1} = 100$ amperes. Now, in point of fact, with most known cells under such conditions about 30 amperes pass. Hence, taking the resistance of the leads,† connections, &c., altogether, and probably some internal chemical actions besides, the resistance works out about 0·3 of an ohm. Let this be so. Let the adjustments of the installation be so made that the mean E.M.F. equal the correct working E.M.F. required for the lamps.

Then any rise or fall of E.M.F. due to the want of regularity in the motor must be neutralised, or nearly so, in order to make no perceptible difference in the light given by the lamps. One point is certain—that if, under the conditions mentioned, the E.M.F. should rise 1 per cent., the increased current sent through the cells will be three amperes, and so on in proportion for any other rise.

Now, in simple shunt machines whose brushes require much lead, the E.M.F. rises with a decreased flow of current in the outer circuit. Therefore a fall in the speed of the dynamo may be made to raise the E.M.F., and, on the other hand, the E.M.F. may be lowered in the case of a rise in the speed.

The important part played by the accumulator is due to the fact that its resistance is small as compared with that of the lamp circuit, and this is essential, for at those *moments* when the speed rises, and the E.M.F. rises with it, and the flow of current in consequence increases, all, or almost the whole, of this increase passes through the cells, so that no alteration takes place in the current flowing through the lamp circuit ; hence the E.M.F. remains practically unaltered at the lamps for any rise of E.M.F. at the terminals of the dynamo. Therefore, if a dynamo, as described and suitably constructed, is employed, very perfect regulation is obtained by the use of cells, whether the E.M.F. rises above or falls below the normal ; the cells and dynamo combined neutralising the rise of, and the dynamo making good the fall of E.M.F., since the variations in the speed are momentary.

If the increase of speed were to continue, there would be a general rise of E.M.F. throughout the circuit, that is, rapid variations would be counterbalanced, but a permanent and considerable rise in the speed would cause a slight and permanent rise of E.M.F. throughout the circuit.

From the foregoing we may conclude the following facts :—

(1) That it is necessary to use dynamos requiring a considerable lead for the brushes, so that the E.M.F. shall rise as the current flowing in the outside circuit decreases, and *vice versâ*, if it is required to steady the light given by the lamps by means of accumulators.

(2) That simple shunt machines, requiring practically no lead for the brushes, and consequently an E.M.F. almost constant for all values of the current flowing in the outer circuit (especially if the magnets are nearly saturated), are not so suitable for use with accumulators for the purpose of steadying the light, although they can be used with good results for charging the cells. For example : a Siemens' SSD_{10} machine (for 300 lamps of 20 candle-power), whose brushes require a considerable lead ; the variable current to the cells due to variations in the speed of the engine was 2 amperes (25 to 27 amperes to the cells). At the same time the variation in the lamp circuit due to any rise or fall of E.M.F. was absolutely *nil*, being steady at 24 amperes. The experiment was then repeated under the same conditions with a Crompton 14-unit dynamo (for 250 lamps of 20 candle-power), requiring a small lead for the brushes. Result : variable current to cells 2 to 3 amperes (25 to 28 amperes) ; variable current in lamp circuit 1 ampere (24 to 25 amperes). Consequently this dynamo did not regulate quite so well.‡

(3) That, in any particular installation, any apparatus or machine giving a counter E.M.F. equal to that of the accumulator in use, and having a like resistance, will steady the light just as well as the cells. This method the author believes to be quite new, and one capable of considerable development. For instance, a motor working parallel in the circuit, giving a constant counter E.M.F. (a motor not difficult to arrange), and having an armature of very low resistance, will effectually steady the lights with a very small expenditure of power. The chief advantage of cells is that most of the power is stored chemically, whereas in the motor-regulator it is lost—yet for many purposes the end gained is worth this loss many times over. It must also be observed that any motor, in a factory or elsewhere, with an unvarying load, and using a large current as compared with the "variable regulating current," will become a good motor regulator, with practically no loss of power. In most cases where motors are in use in parallel with lamps, some method can always be devised for making the motor regulate at the same time.

For another method, suppose the counter E.M.F. of the motor-regulator to vary, it will evidently do so in proportion to the variations of the E.M.F. in the lamp circuit. Hence the motor might regulate the steam flowing to the steam engine, or gas going to a gas engine, in such a way as to regulate the speed of the engine ; hence the E.M.F., very like an electrical governor in its action ; or the variations in the motor may vary the speed of the dynamo, leaving the speed of the engine unaltered. Or variable resistances might be inserted in the main leads, or in the F.M. shunt coils, &c.

The following is a very good way of inserting a counter E.M.F. in any installation :—Let the engine drive a dynamo (let it be called dynamo-regulator) in addition to the generator. If the speed of this dynamo-regulator is very high, and the belt driving it light, long, and slack, and its pulley made heavy to act as a fly-wheel, then this dynamo will have practically a constant speed, even when the engine is not running evenly, *i.e.*, the belt will slip over the pulley sooner than vary its speed, and the power required to drive it will be very small. To run the generator at a constant speed by this method would be too wasteful. Suppose this dynamo-regulator to be placed in "parallel," then it will give a nearly constant counter E.M.F., and this should be arranged to be nearly equal to the normal E.M.F. of the installation. It is evident that any variation in the E.M.F. above the normal, in the main circuit, will be neutralised in the same way as described in the case of the motor-regulator. Such a dynamo-regulator, employed in an installation where a gas-engine is in use for the motive power, and no accumulator, would be found invaluable, rendering the light quite steady, a result almost impossible at present, when only a few lamps are on, and at best there is a slight pulsation in the light. The power absorbed by the dynamo-regulator may approximately be estimated as follows :—Suppose the machine to be a "simple shunt," then the whole power required to drive it, so long as the gas-engine runs evenly, is equal to the power absorbed in revolving the armature when producing the F.M. shunt current. To produce a counter E.M.F., say, of 100 volts in a 100-lamp (20 candle-power) installation would require about 0·5 I.H.P. in a suitably-constructed machine. Hence this is a constant loss all the while the engine is running. Probably this loss of power is set at too high a figure. Now, when a gas engine is working near full power it runs fairly steady, and there will be but a trival variable regulating current passing through the dynamo armature ; hence, the loss of power under this condition will not be increased to any practical extent. But when the engine has only a light load on it, and its speed irregular, then the loss of power in consequence of the variable regulating current being larger will be greater, as much possibly as 0·5 I.H.P., so that, when few lamps are in use, the extra power required to steady the light will be about 1 I.H.P. This seems very wasteful, but a great difficulty is overcome : that of getting a perfectly steady light from a gas engine when only a very few lamps are in use, and the more that are in use at a time the less the loss, till finally the loss becomes very small as compared to the total power required ; yet all through the process the benefits of perfect regulation exist.

It will be observed that by all these methods both rise and fall of E.M.F. above or below the normal will be neutralised.

(4) That, if a variable resistance is employed in the shunt circuit of the dynamo, it is possible to charge the cells at any desired rate from the current given at the maximum E.M.F. the dynamo is arranged to give, down to *nil* ; and this plan avoids all necessity for altering the speed, and the loss of power is very small. This method has always been employed by the writer, and has many advantages in practice. It is thus possible to work on the lamp circuit and charge at any desired rate at the same time, and in addition any desired E.M.F. may be obtained in the lamp circuit.

But the condition exists that so long as any current is entering the cells, all the current to the outer circuit is supplied by the dynamo ; and this continues until the current to the cells, by means of gradually increasing the shunt resistance, is regulated down to *nil*, when unstable equilibrium ensues, and the current to the lamp circuit is at a given moment taken half from the dynamo and half from the cells, and this relation will continue for all values of the current within the limits of the installation.* These last remarks require a slight modification in practice, for they neglect the resistance of the leads between the dynamo and the accumulator, any variation of the resistance of the cells, and any difference in the relations between the resistance of the cells and that of the armature. If all these points are taken into consideration it will be found that the exact proportion of discharge from the dynamo and the cells, instead of being equal, will be somewhat different, but not very much so ; and in the writer's installation, after experimenting with many dynamos and two sets of cells, he finds the theoretical division to be very close in practice, the leads having a very small resistance, and the dynamos being fairly suited to the accumulators. Besides other advantages gained by this method, the cells cannot be injured by overcharging or be charged too rapidly.

In short, after the point of unstable equilibrium has been reached, a dynamo and accumulator work to the line very much in the same way as two batteries, giving the same E.M.F., placed parallel, would act under similar conditions. It is also seen that, in cases where dynamos requiring much lead for the brushes are used, any decrease of resistance in the outer circuit acts in the same way as putting more resistance into the shunt circuit, and thus tends to approach the unstable equilibrium point, whereas when using those machines, requiring practically no lead

* The required difference of E M.F. to obtain the best charging current varies with the cells employed.

† Messrs. Siemens' method of describing their conductors is the number of yards to 0·1 ohm. It is safe to pass the same number of amperes as the number of the conductor for short periods, and half its number for continuous working.

‡ This illustration must not be taken as expressing any opinion on the relative value of the dynamos, but only to indicate the action of each type when employed with an accumulator.

* If more resistance is inserted, then the dynamo runs as a motor, and no longer works as a generator.

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for the brushes, the outer circle may be supplied almost indefinitely (within the capacity of the machine) from the dynamo, charging the accumulator at nearly the same rate all the time.

The author finds that with a Marshall steam engine, fitted with Hartnell's governor, the fluctuations of E.M.F. (standard 100 volts) make but an increased flow of two to three amperes to the cells when the dynamo (Siemens SD_2 or SSD_{10}) is set to charge the accumulator at the same time as supplying the lamp circuit, adjusted by means of the shunt resistance to near balancing point; and further, the nearest approach to unstable equilibrium, so as to work the lamps from the dynamo only, is that of passing three to five amperes to the cells—that is to say, if further resistance is put into the dynamo shunt circuit, at any moment unstable equilibrium ensues, due to the slight irregularity of the steam engine. Hence the rise of E.M.F. is limited to 1 per cent. at the terminals of the dynamo. Many experiments tend to show that in a well-arranged installation, where a gas engine is in use, the E.M.F. at the terminals of the dynamo need not vary more than ± 2 volts, and for steam engine ± 0·5 volt, these values being measured with no accumulator in circuit.

In order better to understand how the dynamo can charge the accumulator at various rates, and work to the lamp circuit at the same time, without injury to the lamps, it must be explained that one of the lamp mains must be capable of being connected (in a 100-volt installation) to the 45th cell during the time that the cells are being charged at the rate of 30 amperes, because 45 cells give 90 to 92 volts, and 10 per cent. more at the time of maximum charging, namely 99 to 101 volts. Again, if the charging is carried on at a lower rate, the lead mentioned must be switched to the 46th or some other cell till, at balancing point, the 49th or 50th is reached. Complicated as this method may appear, nothing can be simpler in practice.

It must be observed that, when charging 50 cells, and one of the lines taken off the 45th cell, the remaining five act as a counter resistance in the lamp circuit, and these have to pass the total current given by the dynamo. The evil effects of so large a current often flowing through them may be prevented in many ways, such as by creating a shunt to these cells, or having the five cells larger, so as to pass more current, or by coupling these extra cells with an equal number of the others in parallel, &c.

There is another way of looking at an installation worked with an accumulator. Let the lamp circuit be regarded, as a whole, as a variable resistance, and the accumulator as a nearly constant resistance. Then in reality the installation consists of a constant resistance with a variable shunt resistance (viz., the lamps). This is possibly a new view of the case, and a very convenient one for solving problems.

(5) That the total capacity of any installation equals approximately the total current which may safely be taken from the cells, together with an equal current from the dynamo, if dynamos having but little lead for the brushes are excluded.

This conclusion dictates conclusively the maximum size of dynamo, in point of economy, required in such installations.

(6) That the results here detailed may lead to many modifications in dynamos, by employing some form of counter E.M.F. regulator, instead of aiming at regulation in the machine itself, as done at present. The advantage of using this regulator will be that the machine can be made far simpler, with very few coils in the armature, and few plates in the commutator, and if massive soft iron field magnets are employed there will be no sparking; hence a very simple machine might come into use, with good efficiency, and wound in the simplest way, capable of being used as a direct lighting machine with very good regulation, or for charging accumulators by switching on the cells in the place of the counter E.M.F. regulator.

(7) That the size of accumulator to be used in any particular installation depends on the class of dynamo used, for if its E.M.F. rises rapidly for a decreased flow of current to the outer circuit, then clearly the accumulator may be of smaller size than when the reverse is the case, so that a small accumulator will serve to regulate a large installation if the dynamo is made suitable—that is to say, what would be called a badly regulating dynamo under some circumstances would here be the best machine. Further, the accumulator must be of very large size, if to regulate at all, with dynamos requiring a very small lead for the brushes. In all cases the resistance of the cells must be small compared with that of the lamp circuit.

(8) That as a general conclusion from the above—

(i.) If dynamos requiring much lead are used, steadiness of light is secured; but it must be observed that the lamps will get a little brighter as the "run" proceeds if the current flowing to the lamp circuit remains unaltered, because the counter E.M.F. of the cells increases as the charging advances, so that the total current given by the dynamo decreases, and the E.M.F. consequently has a permanent rise.

(ii.) With dynamos having but a very small lead, the E.M.F. in the lamp circuit remains constant at all periods of the charging, except at those moments when the speed of the machine is irregular and these variations at the terminals of the dynamo are much reduced at the lamps.

(iii.) Lastly, if a dynamo as in case (i.) is employed, and a dynamo or motor regulator is used, both defects above mentioned are overcome.

The following is a method for ascertaining what size of accumulator should be chosen for any particular installation:—

Let R = resistance of cells;
" nR = resistance of lamp circuit;
" a = *momentary* variation of E.M.F. above the normal, owing to irregularity in speed;
" E = normal E.M.F.

Then, if the dynamo is a suitable one, all *momentary* fall of E.M.F. below the normal will be compensated for, and the *momentary* rise of E.M.F. is all that has to be neutralised at the lamps.

Hence, the rise of E.M.F. at the lamps will never exceed

$$\frac{R}{nR} \times a = \frac{a}{n},$$

and the limits of E.M.F. will lie between E and $E + \frac{a}{n}$.

Thus, if a is large, n must be large, or else $\frac{a}{n}$ has a large value, for it is required that $\frac{a}{n}$ shall be made as small as possible.

In all installations the value of a can be ascertained, so that n has to be found. It must then be decided as to how small a variation of E.M.F. is to be allowed at the lamps, and the latitude will depend upon what the light is to be used for; this point settled, the value to be given to n is known.

To find what amount of lead a dynamo should have in any given installation,

Consider only the fall in the speed;

Let k = a constant expressing the percentage of *momentary* fall in the normal speed of engine when not working regularly.

Now, the E.M.F. varies very nearly direct in proportion to the speed, when these are compared at rates not differing much from one another.

Then the varying E.M.F. below the normal may also be expressed by k; hence, to keep the current flowing to the cells *momentarily* constant for the decreased speed, the E.M.F. should be made to rise a percentage equal to k, and this can be accomplished in the construction of the dynamo.

For the lead of the brushes may vary 90°, which may be interpreted that at 0° the E.M.F. is constant for all values of the current flowing to the outer circuit, speed remaining constant, and close to 90° for a very small difference in the quantity of current taken off, an immense difference in the E.M.F. would follow. The lead can never actually be made to exist at 0° or at 90°, but at any point between. And the *lead* and *rise in the E.M.F.* for a decreased flow of current in the outer circuit vary directly with one another, when compared at close intervals of variations hence the *extra lead* required to keep the E.M.F. constant at the lamps for any *momentary* fall in current flowing to the outside circuit due to irregularity in the engine is $k \times 90°$. If the usual current given by the dynamo requires a lead of $g \times 90°$, then for this machine to work with cells in any given installation the lead must be made $(g+k)$ 90°. From this it is seen that g may be made as small as desired, or variable, but k depends on the character of the installation. It may be noticed that $k = a$ in the last investigation.

To obtain the required *extra lead* $k \times 90°$,

Let n = polarity of the armature;
" m = polarity of field magnets;
" p = angle of lead;

Then $\frac{n}{m} = \sin. p.$

In the case under consideration, p being known, namely $(g+k)$ 90°, the relation $\frac{n}{m}$ may be arranged as most convenient.

Returning to a 100-volt installation (50 lamps 20 candle-power) with a gas-engine, if we have $n = 20$ and $a = 2$, then the E.M.F. at the lamps will vary from 100 to 100·1 volts; and if a steam-engine replaces the gas-engine, and $n = 20$ and $a = 0·5$, then the E.M.F. will only vary from 100 to 100·025 volts. Lastly, if it is allowed to vary the E.M.F. as much, say, as one per cent., many combinations may be employed, from a very irregular motor to a very small accumulator. Also the *extra lead* will in the first case be 1·8°, and in the second one 0·045°.

COMPANIES' MEETINGS.

The Australasian Electric Light, Power, and Storage Company (Limited).

An extraordinary general meeting of the shareholders of this Company was held at the offices, 41, Coleman-street, on the 10th inst., under the presidency of Mr. Latimer Clark.

The SECRETARY (Mr. J. H. Duncan) read the notice calling the meeting.

The CHAIRMAN stated that they had met that day to adopt the report of the Directors and accounts, and to consider the report of the committee appointed at the meeting on the 30th December to confer with the Directors as to the past history and present prospects of the undertaking. The committee issued their report on the 21st of February, the Directors sent out a circular on the 26th of February and a sort of reply on the 4th of March. That committee was formed in pursuance of a suggestion by the Directors in the report, which they were, he hoped, going to adopt that day. They stated in their report that they would "welcome the appointment either of another nominee of the shareholders (preferably a large holder of original shares) to join the Board or of a small committee of consulting shareholders to advise in the place of Mr. Hammond." The committee was formed in consequence of the action of several shareholders at previous meetings, who had expressed themselves very much dissatisfied with the results obtained or with the management of the Company. The committee was formed and had now given in their report. The gentlemen forming the committee were chosen from amongst those who spoke in the

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most hostile manner at the last meeting, and therefore the Directors could not be accused of any partiality or attempt to pack the committee. The Directors were not unconscious that they had the support of the large body of shareholders when they allowed the committee to be formed, and the majority of hands held up in favour of the committee was extremely small, the numbers being 11 for it and 9 against it. The Directors themselves did not vote. The result had been what the shareholders saw. They had been somewhat blamed for the course which they took by some large shareholders, who had said that the interests of the Company would not be served by the public washing of their dirty linen, and that the Directors had been wrong in bringing into existence such a committee. Perhaps, had the Board foreseen all that they now knew, they would have been wiser had they held up their hands and prevented the formation of the committee. But they felt when their honour was in question that it was their duty to create the committee. They were very much gratified that it had been called into existence on one account, namely, that it had enabled all the shareholders to see that there had not been at any rate any wilful wrong doing. Unfortunately the report of the committee had found its way into some of the newspapers, and had caused some little inquiry among those with whom the Company had financial and other dealings, and it would no doubt get into the colonies, and must do the Company harm. He hoped, however, that at that meeting the good done would counterbalance this harm. The committee having had full access to documents, and having read them as far as they were able, did not communicate to the Directors the opinions and views they had formed. If they had done so the Directors had no doubt that many of the views formed by the committee would have been very much modified and changed. They were perfectly unable in the time they devoted to the subject to read he might say any of the correspondence on which all the actions of the Board had been based. They were compelled to take merely the minutes, and to form their opinion upon them. They were justified in doing so, but they had naturally fallen into error, as any of them would do who formed their views merely from a rather cursory investigation that a reading of the minutes would give. The committee had declined to let the Directors know what their conclusions were; and as they sent out their report to the shareholders without letting the Directors see what it was, they had no alternative but to make a reply such as they could in a brief way, and that was the situation they had now to deal with. The report of the committee really practically contained one recommendation, which was that the Directors should resign as a body. He regretted to inform those who wished the Directors to resign that they did not see their way to do so, and the large body of the shareholders were of the same opinion as the Directors. Proxies had been sent out and returned, and they showed an overwhelming balance of opinion in favour of the Directors retaining their seats. They had received some 10,000 proxies in favour of their continuing as they had done, and about ten in favour of their retirement. There was one other recommendation made in the report, which had reference to the Directors' fees, but those two were the only real practical suggestions made in the report. The rest consisted rather of animadversions on the past management of the Directors. As to the latter matter they had never failed to admit that they had made the greatest blunders, the fact being that they had all been carried away—the shareholders as well as the Directors—by the enthusiasm and mania which formerly existed as to the electric light. He knew nothing like that event since the days of the South Sea bubble. It was difficult now to realise it. But he might mention one fact. After Sir Julius Vogel left some responsible gentlemen came to the Board and offered them £20,000 for the right of their patents in New Zealand. Shareholders would suppose that the Directors would have accepted this offer, but they politely bowed those gentlemen out of the room. They were also asked to put prices on their patents, and they did so at figures which now looked fabulous. Those circumstances, however, showed that they were not acting under the same cool judgment and knowledge of the facts as they now were. As to their fees, they were asked by the committee to strike out the sum which stood to their credit in the profit and loss account, but they had stated that they would never take that money unless the Company were earning a dividend. They resented being dictated to by the committee on this point, and they declined to do more than say what they had said before—that they would never take that money unless the Company were earning a dividend; and even if it were earning a dividend they would be quite prepared to, and would, reduce that amonnt. Their great object at the present moment was to avoid a call, and those gentlemen who would get up presently and address the meeting should, he thought, avoid saying anything to damage the interests of the Company in future. He was happy to say that the tide had now somewhat turned. They had promises now of remittances from Australia, and they had negotiations going on for large and new contracts there which he hoped might come to fruit; and therefore he looked with some pleasure to the future. Before sitting down he would wish to refer to a personal matter. The committee had expressed surprise that he should have allowed himself to be placed in a position of a dual character. But in that they were somewhat mistaken. There was nothing of the kind in the matter. The interests of the firm which he represented and of the Company were identical. No profit could be made by one without a profit to the other. It was true that there was afterwards disagreement as to this arrangement made between the Company and his firm, and that the Directors had wished to terminate the arrangement. When that occurred he was in a dual position, but it was one he could not have foreseen, and he gave every assistance in the closing of that negotiation. Moreover, he took no part whatever in the discussions on the subject at the Board.

Mr. WAINWRIGHT, who stated that he represented not only himself but other shareholders, complained of the £500 a year which was paid for offices and clerks. As to the proxies, they all knew that this was the most objectionable form of voting in the City of London, because people who voted by proxy knew nothing of what was going on in connection with the management of the Company. In the case of similar companies, the Directors had seen that the proper course was to wind up, and there was no doubt this Company ought to have been wound up two years ago. He expressed his intention of voting for a change in the management.

Mr. T. B. WILLIAMS asked the approximate profit on the work which had been mentioned by the Chairman.

The CHAIRMAN stated that there were objections to giving the information, as they had rivals. He then formally moved the adoption of the report and accounts.

Mr. CATER seconded the motion.

A SHAREHOLDER thought that six Directors in London were unnecessary, seeing that the whole paraphernalia connected with the management was in the colonies. He thought that there should be only half the number, and that the Directors should forego their fees. He would also like to ask if there were any number of men in the City who could justify the sending out to Australia of Sir Julius Vogel at ten guineas a day. In his opinion the Chairman had not upset a single word of the report of the committee.

Mr. BENJAMIN KISCH (of the committee) said he was glad to see from the general feeling of the meeting that they had been convinced of their own accord that all the conclusions of the committee were perfectly justified, and they had not been rebutted in any way by the reply which had been issued by the Directors. The committee had conducted their inquiry throughout without any feeling of animus towards the Board, acting merely in regard to the pecuniary interests of themselves and of the shareholders, whose interests were identical. As to what the Chairman had said, that the committee in some respects had not carried out their mandate, a reference to the original resolution appointing them would show that by its terms they were "to report to a further meeting of shareholders," not to the Board, and they therefore had thought it their duty to report directly to the shareholders. They had been a little reproached for not discussing other matters with the Board, but as regarded the future they were in the hands of the Board as to what matters should be discussed. They did not know beyond what the Directors told them what the Board were doing or contemplating. As to the past, they did not feel that they were warranted in occupying their time. However, wherever they had been in doubt they had consulted the secretary, and in fact the Board through that gentleman. But that was to set themselves right as to facts, and he submitted in the result that they had all their facts correct. The Chairman had referred to the large number of proxies which the Board had received, and the small number the committee had received. No doubt that was the case. But the committee had not wished to enter into a contest with the Board, feeling that that would have been against the interests of the shareholders. He might say that the vendors of the Company received between them 6,000 shares credited as fully paid up, and he need not say that all the votes attaching to those shares were included in the Directors' proxies.

The SECRETARY: That is not the fact.

Mr. KISCH: Well, almost all. Continuing, he said that he saw in the list of proxies a large number of vendors' shares, even those which were intended, according to the statement before them, to be surrendered. Sir Julius Vogel's 1,552 shares were put down on the list of proxies, and a vast number of others; and one of his colleagues reminded him that there were about 600 shareholders, and about 49 on the list of proxies. He desired to state that they had no intention of entering into a contest with the Board, but, what was much fairer, to judge of their support by the independent action of the shareholders in the room. He then went through the report which had been issued by the committee, as it had been stated by the Directors that there were certain erroneous conclusions on many points. In the course of his remarks he referred to and criticised the terms of Sir Julius Vogel's appointment, and maintained the accuracy of the remarks of the committee as to the New Zealand Company. As to the accumulator option, the Directors in their reply had stated that "the purchase was carried through after long discussion, and with the utmost circumspection, the payment over of the money being left absolutely in the hands of the Company's solicitor." The Company's former solicitor was present, and would no doubt give his version of the matter. Having alluded to other points dealt with in their report, he asserted that in no material respect had any of their conclusions been successfully impugned. As to the question of the Directors' fees, he did not think the shareholders would be satisfied with what the Chairman had said, for if the matter remained in that way the suspense account would go running on from the 30th of June last at the rate of £1,000 a year. Seeing what the Directors had done so far, he did not think it was too much to ask that those undrawn fees should be waived. They did not bring forward any resolution of their own, but left the matter in the hands of the meeting.

Mr. FRANCIS INCE stated that he was unfortunately one of the largest shareholders of the Company, and also o iginally the solicitor of the Company. He felt bound to make one or two remarks as to the accumulator option, the position of which was to a certain extent a simple one, so far as the Company was concerned. At a Board meeting Sir Julius Vogel came into the room and told the Directors he had secured the option of the purchase of the Sellon-Volckmar patents up to four o'clock that day, if the sum of £5,000 was paid, the option extending for a year. The Directors then requested Sir Julius Vogul to attend at four o'clock with the solicitor to the vendor company and himself (Mr. Ince), and to see the solicitor to the Sellon-Volckmar Company and ascertain whether an agreement for the purchase of the patents with the option of purchase for a year could be entered into, and practically his (the speaker's) instructions at the time were to part with the £5,000 almost on any terms, in order to secure the option, because the Board believed it would be a very valuable patent to secure. He received his instructions as solicitor of the Company, without any respect to any electrical knowledge he might possess. He believed at the

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time that the arrangements were proposed to be made as to the Sellon-Volckmar option that the Sellon-Volckmar patents were practically worth very little. There was a clause in the agreement that was sufficiently clear to have entitled the Company to recover back the £5,000, and his view of that clause was agreed to by Mr. A. L. Smith, now Mr. Justice Smith, who was his counsel, and who advised that the money could be recovered; and the reason the action failed was that the Directors of this Company were not aware of prior negotiations that had taken place between Sir Julius Vogel and Sir Daniel Cooper, one of the Directors of the Sellon-Volckmar Company, of which neither he nor the Directors were aware. Again, Sir Julius Vogel was sent to act in good faith with Mr. Trinder and himself before parting with the £5,000; but it was not known to the Company nor to him that Sir Julius had stipulated that on any amount this Company might pay he would receive a commission of 10 per cent. If he (Mr. Ince) had known for a moment that such a stipulation had been made he would have told Sir Julius Vogel that he would have been no party to paying over this money—that he could not advise the Company to part with the money, and he would have told Sir Julius Vogel in language very plain what he thought of him. He had no doubt that the Directors believed, as he did when he reported the terms of the draft agreement, that they would be able to recover the money, and so they would had all the circumstances of the case been known to them at the time, and were as they believed them to be, and not as Sir Julius Vogel knew them to be.

Mr. FREDERICK ROBERTS asked whether Sir Julius Vogel could not be sued for the £5,000 if he had acted as the Company's agent in connection with this option, and had yet stipulated with the other side that he should have a commission. If that were so, he would have acted in a dual capacity.

Mr. PHILIP FALK (a director) argued that the Directors, after all, were not to be blamed in the way that the committee had suggested. He had been interested in Australasian business for thirty-five years, and received a great deal of information from people carrying on business both in Melbourne and Adelaide. He had held his shares and he felt that the time had arrived when they were going to turn the corner. When the third call was about to be made some of the Board took into their most serious consideration whether the time had not arrived for them to go into voluntary liquidation. But such were the statements of business put before them that they could not undertake the responsibility of such a step. He maintained that the committee were now in the very self-same position that the Directors were in two years ago, for they had themselves shrunk from saying that the Company should wind up.

Mr. INCE stated that the committee did not advise winding up, but they would have done so if they could have seen their way. If they wound up, the first thing a liquidator would have to do was to make the last call, in order to make the shares all paid up, and in that case the vendors would get more of the shareholders' money. He had omitted to speak about the Directors' fees. The Chairman had said that they were not going to ask for the fees until a dividend came in the future. But there was another reason. Those fees were put to a suspense account because if there was a winding-up the Board would have a claim against the assets, and ask for payment of every shilling of the money. The Board had admitted that they had made great mistakes in the past, and if that were so, was it not right, equitable, and just that the Directors should give up all claim to the fees in question?

A SHAREHOLDER asked whether the Directors were willing to retire.

Mr. M'LEAN asked the Directors to make a clean breast of all they knew about Sir Julius Vogel.

Mr. R. E. STEVENS thought they might let Sir Julius Vogel off, as he had surrendered his shares, and he did not believe they would get anything more out of him. With regard to what the Chairman had said about their voluntarily inviting the appointment of a commitee, he maintained that it was a matter of Hobson's choice with them.

Mr. THOS. PEARSON and Mr. LYALL having spoken, the latter gentleman maintaining that the arrangements with Sir Julius Vogel were most preposterous,

Mr. ROBERTSON asked if the Directors retired whether there was anybody else to take their place. He thought, as a small shareholder, that though the Board had made mistakes it was for them to pull the Company out of its difficulties. He thought the report of the committee had told them nothing beyond what they knew.

Mr. B. H. VAN TROMP, in answer to a shareholder, said that he could add nothing to what had already been said by other members of the committee. He was distinctly of opinion that it was not necessary, on account of what was stated in the report, and also on account of what Mr. Ince had said, that they should go into voluntary liquidation at the present moment, because if they did every shilling of the money would be lost, and it was better to go on to the end in the hope and expectation, and, he thought, the reasonable possibility of a great improvement in Australia with regard to electric lighting. He was prepared to do exactly what the meeting wished, to act with the present Directors, of whom he was now one, or with any fresh gentlemen whom they might appoint.

The CHAIRMAN, at the close of the discussion, replied, and stated that there had been a general inclination on the part of every one to mix up all the early mistakes made by the Board, which they had frankly admitted, and to assume that all those mistakes were still going on as before. He believed that Mr. Van Tromp would tell them that the Directors were now, and had been for twelve, sixteen, or eighteen months before his accession to the directorate, aware of their mistakes, and had entirely altered their policy. They had reduced the expenditure, and were still continuing in the same direction, and would bring the expenditure down to the utmost possible limit. There had been a strong feeling expressed against their continuing in office, but he wished to say that if they resigned someone must take their place, and he had no doubt that many gentleman would be quite willing to do so, and competent to a certain extent, but they would not have the advantage of the long previous knowledge of the Directors. Again, the Directors had to represent not merely a portion of the Company, but the whole of the shareholders of the Company. He had carefully noted down the speakers, and the total number of shares held by those in favour and those against them was extremely small compared with the generality of the shareholders. They were certainly not disposed to resign their seats. As to their fees, they had been disposed to deal liberally with the shareholders in the matter, and he believed they had done so. But at the present moment he did not feel that they would give way before the pressure which had been brought to bear upon them. Sir Julius Vogel took himself 250 shares, and he received 1,542 vendors' shares from the Company for forming the Company. The vendors' shares he had given up.

A SHAREHOLDER: Can the Secretary tell us how many golden sovereigns Sir Julius Vogel had?

The SECRETARY said that he believed Sir Julius Vogel had received 1,542 shares in this Company as his repartition of vendors' profits. £45,000 was paid for the patents in cash and £30,000 in shares. As a matter of fact he believed that each of the vendors had £30 or £40 and their shares. The profit of the vendors was in shares. [A Voice: "They sold their shares at a premium."] He believed none of the vendors had sold their shares with one exception, and he (the Secretary) was himself the purchaser of those shares.

The CHAIRMAN then put the resolution to the meeting, and declared that the show of hands was distinctly against it, but as the number of votes was in favour of the Directors he declared the resolution carried.

Mr. INCE said that he would demand a poll unless the Directors gave way and consented to forego their fees.

The CHAIRMAN again declined to accede to this request, and a poll was accordingly demanded, which it was arranged should be taken on Monday next, between the hours of eleven and two o'clock, at the office of the Company.

A resolution was afterwards passed voting £100 to the committee in recognition of their services, and the proceedings then terminated.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. MAR. 12.		BUSINESS DONE WEEK ENDING MAR. 12. Highest.	Lowest.
Anglo-American	29½,	30½	30⅜	30
Do. Preferred	53½,	54½	54½	54
Do. Deferred	7½,	7⅝	7 11-16	—
Brazilian Submarine	11⅛,	11⅜	11⅜	11⅛
Cuba	10¾,	11¼	11	—
Do. Preference	17,	18	—	—
Direct Spanish	1¾,	2¼	—	—
Do. Preference	10½,	11½	—	—
Direct United States Cable	9½,	9¾	9 15-16	9¾
Eastern Telegraph	11⅞,	12⅛	12⅛	11 15-16
Do. 6 per Cent. Preference	13¾,	14¼	13⅞	13¾
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	12⅞,	13¼	13¼	12⅞
German Union	9½,	10	9⅝	—
Globe Telegraph and Trust	6¾,	7	7	6 15-16
Do. Preference	12¾,	13	12 15-16	12¾
Great Northern	15,	15¼	15	—
Indo-European	32,	33	—	—
Reuter's	7½,	8	—	—
Submarine	180,	190	—	—
West India and Panama	⅝,	¾	⅝	—
Do. 1st Preference	7½,	7¾	7⅝	7½
Western Brazilian	6⅜,	6⅝	6¼	6 5-16
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	½,	⅝	9-16	—
Oriental	⅜,	⅝	—	—
United Telephone	10½,	11	11⅜	10½

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞	1 7-16	1 5-16
Do. (fully paid)	3,	3½	3 3-16	3¼
Hammond Light (£3 15s. paid)	⅝,	⅝	7-16	—
Swan	¼,	¼	¼	—
Maxim-Weston	3-16,	5-16	—	—

MISCELLANEOUS.

Telegraph Construction	35½,	36½	36¼	35½
India Rubber, Gutta Percha, and Telegraph Works	20,	21	20½	20¼

TRAFFIC RECEIPTS FOR FEBRUARY, 1885.

COMPANIES.	Feb., 1885.	Feb., 1884.	Increase.	Decrease.
Cuba Submarine	2,700	3,099	—	399
Direct Spanish Telegraph	1,457	1,588	—	131
Direct United States	—	—	—	—
Eastern Extension	40,114	38,900	1,214	—
Eastern Telegraph	61,784	57,396	4,388	—
Great Northern	20,400	—	—	—
Submarine	—	—	—	—

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NOTES.

CABLE INTERRUPTION.—The cable between Maranham and Para is interrupted.

COMMUNICATION WITH PARAGUAY.—Telegraphic communication has been established with Paraguay in South America.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ended 6th and 13th March amounted to £3,543 and £2,690 respectively.

NOTICES OF REPAIR.—The cable between India and Ceylon is repaired. The cable between Trinidad and Demerara is also repaired, and telegraphic communication is therefore restored with British Guiana.

ELECTRIC LIGHTING AT LLOYD'S.—The lighting of the hoist is now done electrically by means of E. P. S. accumulators. A set of cells will supply the current for about a fortnight, working 10 hours a day, after which the cells are replaced by another set fully charged.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the weeks ending 6th and 13th March were £2,845 and £2,072, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

NEW BOOK.—We have received "A Collection of Examples on Heat and Electricity," by H. H. Turner, B.A., Trinity College. The work, which is published by Macmillan and Co., deals with abstruse mathematical problems presented in the study of heat and electricity.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th March are £2,925, as compared with £2,770 in the corresponding period of 1884. The December receipts, estimated at £4,468, realised £4,619.

THE SUAKIN-TRINKITAT CABLE.—In our issue of the 14th inst we announced that this cable would probably be completed and at work by the 18th inst. The steamship "Chiltern" has arrived at Suakin with the cable on board, but in all probability will await the orders of the Commander-in-Chief before proceeding with the work.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.—A meeting of this society will be held at 25, Great George-street, Westminster, S.W., on Thursday, 26th inst., when there will be read the paper now appearing in *The Electrician*, on the "Seat of Electromotive force in a Voltaic Cell," by Professor Oliver J. Lodge, D.Sc.

QUADRUPLEX WORKING.—The electrician of the Wheatstone department in New York has devised a plan for quadruplexing the wires assigned to the Wheatsone system and utilising the neutral side for Morse working. As now arranged the wires are operated upon the duplex method, and the improvement would be in effect a gain of two wires. The trial tests of the apparatus have given favourable results.

LIGHTING OF THE SENATE CHAMBER AT WASHINGTON, U.S.A.—The Edison Company have successfully made the experiment of lighting the Senate Chamber and lobbies at Washington. It is said that the funds necessary for a complete installation in that wing of the Capitol will at once be appropriated; the lighting of the House end of the buildings remaining in abeyance until the result of more extended experiments is known.

FOREIGN EXHIBITIONS.—As announced in our last issue, the opening of the Electrical Exhibition in Paris will take place to-morrow. The inauguration, at which the President of the Republic will assist, is fixed for to-day (Saturday). Prices of admission to the Antwerp Exhibition, which is to be held on the 2nd of May next, have been arranged as follows:—For each person, between the hours of 8 and 10 a.m., 2 francs; after 10 a.m., 1 franc only.

THE TELEPHONE AND THE NEWSPAPERS.—Messrs. Horncastle and Co., advertising agents, of Cheapside, E.C., received on the 17th inst., direct by telephone from Brighton, the actual words and instructions respecting insertion of an advertisement in a daily paper of the 18th inst. The whole transaction only occupied a couple of minutes. This is, we (*City Press*) believe, the first practical use of the telephone for newspaper purposes over so long a distance.

THE GLOBE TELEGRAPH AND TRUST COMPANY.—The directors at the Board meeting, held on the 17th inst., declared the payment of an interim dividend on and after the 20th April of 3s. per share on the preference shares, less income tax, and 2s. per share on the ordinary shares (income tax having already been deducted) for the quarter ending the 18th April, 1885. The transfer books were ordered to be closed from the 13th April to the 20th, both days inclusive.

THE REBELLION IN CENTRAL AMERICA.—The Central and South American Telegraph Company has notified the authorities in Mexico, San Salvador, and Nicaragua that guards have been posted at the cable landings in order to protect them. Mr. Bayard, Secretary of State, has telegraphed to the American Legation in Guatemala, declaring that the United States will hold Guatemala responsible for any injuries to the cables or to American interests caused by her authority or with her connivance.

THE POST OFFICE TELEGRAPHS.—The gross amounts received and expended in respect of the telegraphic service from the date of the transfer of the telegraphs to the State to 31st March, 1884, are stated to be as follow:—The gross amount received for telegrams in that period was £18,225,778, and the amount expended in the working of the department was £16,662,347, and £2,395,082 remained as a balance to meet interest on stock created on account of the telegraph service and the redemption of debt.

THE TELEPHONE IN PARIS.—A GOOD IDEA.—On the 15th inst. there were first issued to the public of Paris a number of telephone tickets, at 50 centimes each. These tickets may be presented at any of the Paris post offices, and entitle the owner to hold five minutes' conversation with persons in any other post office or at any of the Telephone Company's stations. The Telephone Company offers, at the same rate, conversations at any of their eleven stations with persons at any other station or at the residence of any of their subscribers.

THE TELEPHONE IN PARIS.—The Society of Ambulances in Paris have nominated a committee, presided over by M. Jules Simon, for the purpose of determining the best means of securing prompt medical assistance in cases of accident in the public highways. It has been decided by the committee to establish telephonic communication between the chemists and druggists and the hospitals in various quarters of the town. By this means the nature of the accident and of the remedies or assistance required for its relief can at once be indicated.

NEW CATALOGUE.—We are in receipt of the new illustrated catalogue of telegraph materials, electrical instruments, and other apparatus manufactured by Messrs. Latimer Clark, Muirhead, and Co. In addition to a description of almost

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every electrical appliance known to the world, and some valuable hints as to the application of galvanometers, &c., to telegraphic and experimental purposes, the catalogue contains a variety of useful tables and formulæ, treating of units, resistance, temperature, and other matters of interest to the electrician.

SS. "ELECTRA."—The directors of the Eastern Telegraph Company on Thursday invited a number of gentlemen to inspect the new ship "Electra," now lying in the South West India Dock, previous to its departure to Souakin. The ship was agreed on all sides to be an exceedingly fine specimen of what a cable ship should be. The ship is under the command of Captain Pattison, and Mr. Kennelley is in charge electrically. Cable and stores are being rapidly taken on board, and it is expected that the ship will leave about Tuesday next for her destination.

ELECTRIC LIGHTING AT MESSRS. H. J. NICOLL AND SONS, REGENT-STREET.—This firm was amongst the first to adopt the electric light, having used arc lights on the Jablochkoff system for some years past. As, however, some incandescent lighting was required in addition to another arc lamp, it was decided to utilise the existing gas engine to charge accumulators during the day. The arc and incandescent lamps are supplied from a set of the Electrical Power Storage Company's accumulators, and the arrangement gives every satisfaction. The remarkable steadiness of the Brush ratchet lamp when supplied by accumulators may be noticed by any one passing Messrs. Nicoll's at night.

THE TELEPHONE IN BRISTOL.—The Western Counties and South Wales Telephone Company have taken over the business of the United Telephone Company in this district, and have undertaken all existing agreements and arrangements entered into by the latter company. To show one of the uses to which the telephone may be put in a large city like Bristol, it may be mentioned that a fire recently broke out in Southwell-street, Kingsdown, contiguous to the premises of Mr. E. F. Woodward, sanitary engineer, a subscriber to the Telephone Exchange. That gentleman at once telephoned to the central fire station, and in seven minutes a policeman from the Central Police Station appeared on the scene and turned on the water at the street main. In nine minutes the fire brigade were on the spot at work, and the conflagration was stopped before it had time to spread.

THE ELECTRIC LIGHT AT SAINT ETIENNE.—The town of Saint Etienne will, it is said, be the first to possess a central station for electric lighting purposes in France. The arrangements have been completed, and the necessary works already entered upon. The installation, which will be laid down by the Edison Company, will be upon the American model, comprising 3,000 incandescent lamps of 8 and 16 candle-power, and 5 A dynamos for 500 lamps each, with one spare dynamo. These will be driven by four engines of 70 horse-power. The station, placed in the centre of Saint Etienne, will furnish the light for the quarter of the Hotel de Ville, and the number of persons who have tendered their subscriptions for a period of five years is even now considerable. The *cafés*, the theatres, &c., situated in the quarter have all adopted the new luminant. The work, we are informed, will be finished about September.

THE ELECTRIC LIGHT FOR THE SOUDAN.—The electric light and other plant ordered by the Government for the Soudan, as announced in our issue of the 14th, consists of the following :—Six sets of apparatus, by Brotherhood, for 6-1,000-candle lights, with six spare lamps, and three spare lanterns to work on 4ft. 8½in. gauge, trolleys and shears, crabs, ropes and brackets, 500 yards of cable, all complete for lamps, 4,000ft. carbons, wrought-iron dust-proof case with each set. Six sets of ditto, by Kitson and Co. (fitted on trolleys 4ft. 8½in. gauge), each of six lights (Brush), and 800 yards of cable, with lamps, lanterns, carbons for 2,000 hours each lamp, poles, crabs, and appliances for lamps complete. In addition to this there will be for early shipment to Suakin six sets of Siemens' telegraphic apparatus (five miles in each set), with alphabetical instruments and telephones complete, two spare sets of telegraph and four spare sets of telephone instruments.

UNITED TELEPHONE COMPANY.—In order to increase the usefulness of the exchange system throughout the metropolis, the Directors of the United Telephone Company have announced that the London exchanges are now open from 9 a.m. to 9 p.m., instead of from 9 a.m. to 7 p.m., as hitherto. During the Session of Parliament, and until further notice, the West-end exchanges will be open all night—that is, there will be a continuous service at these exchanges by day and by night. The directors have further arranged to connect the exchanges with the Central Telegraph Office in St. Martin's-le-Grand, and all subscribers to the company's system will be able, from their own offices, to transmit and receive telegrams direct through St. Martin's-le-Grand on arranging for payment of the ordinary tariff charged by the Post Office for the transmission of inland and foreign messages. This service will be opened in the beginning of next month, and the United Telephone Company will not make any extra charge for the increased facility thus afforded by the telephone.

LA SOCIETE INTERNATIONALE DES ELECTRICIENS.—The order of the papers to be read at the Conferences of the Society in Paris during the coming week is as follows :—On Sunday, the 22nd inst., at 9 p.m., "Applications of Electricity to Astronomical Observations," by M. C. Wolf, member; March 23, at 8:30 p.m., "Telephony," by M. L. Maiche, electrician; March 23, at 9:30 p.m., "Telephonic Induction," by M. C. Elsasser; March 24, at 9 p.m., "The Electric Light-houses," by M. A. De Méritens; March 25, at 8:30 p.m., "Accumulation and Transformation of Voltaic Electricity," upon the experiments of M. G. Planté, by M. P. Samuel; March 25, at 9:30 p.m., "Applications of Electricity to the Military Art," by M. Le Roux; March 26, at 9 p.m., "Applications of Electricity to Medicine," by M. le Docteur Boudet de Paris; March 26, at 8:30 p.m., "Galvanometric Measuring Apparatus," by M. G. Lippmann; March 27, at 9:30 p.m., "Applications of Electricity to Railways," by M. P. Jousselin; March 28, 9 p.m., "Electric Transport with regard to the Automatic Distributions under Different Forms of Energy," by M. G. Cabanellas; March 29, at 3 p.m., "Applications of Electricity to Weather Forecasts," by M. le Dr. Marié-Davy; March 29, at 9 p.m., "Telegraphy," by M. E. Baudot.

THE NEW MAXIM ELECTRICAL TRAINING GEAR FOR HEAVY ORDNANCE.—The new electrical training gear, described in a recent issue of the *Pall Mall Gazette*, is one of the most important innovations of our day; and is, perhaps, destined to revolutionise the principles which at present govern the training and adjustment of modern ordnance. Mr. W. H. Massey has lately made some very exhaustive experiments with the apparatus, which, it appears, is so contrived that by the movement of a handle the breech of the gun can be moved to the right or left, and the muzzle raised or depressed, as may be desired. Mr. Massey speaks very highly as to the efficiency of its action. The small switch con-

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trolling the speed of the two motors (which may be run together in the same or in opposite directions, or independently of each other in either direction) is a most ingenious piece of mechanism; the movement of the handle making the necessary connections with the motors and also cutting out resistance as it is pushed in the direction in which the breech of the gun is intended to be moved. The gear was applied a few days ago to one of the 38-ton guns at Garrison Point Fort, Sheerness, and it was then shown that one man could train the gun with perfect ease and accuracy. Altogether the thing promises to be a great success, and we trust that Mr. Massey will receive a reward commensurate with his exertions.

ELECTRIC LIGHTING CONVENTION IN CHICAGO.—The first convention of the representatives of the electric lighting interests of the United States commenced in Chicago on the 25th inst., and is well attended by representative men from all parts of the country. The committee on digest of papers and programme of business reported the following order of proceedings and topics for discussion:—1. Incandescent lights particularly in regard to length of circuit upon which they can be run with profit; 2. Locating and avoiding crosses with telephone wires; 3. Power and its conversion into light; 4. Electric light globes and shades; 5. The best modes of connecting dynamos with power; 6. Electric lighting by water power; 7. Rates and rebates on electric lights by the year; 8. The use of electricity as applied to motors; 9. Where an electric light system requires No. 6 conductor, is it desirable to use Nos. 6 and 4 in the same line? 10. Will armatures become affected by frost when exposed in transportation? 11. Special insulation or guards to insulation of lines at dangerous points and places; 12. Street lighting—the best manner and modes of accomplishment, embracing the location of lights and running of circuits; 13. Experience and results in the use of underground conductors; 14. *Resolved*, That the fireman should receive more pay than the engineer; 15. Help generally; 16. Experience of electric light companies in the use of copper-coated and uncoated carbons.

GREENWICH TELEGRAPHIC AND ELECTRICAL SCHOOL.—A new telegraphic school has been opened at the Lecture Hall, Royal Hill, Greenwich, with Mr. S. T. Dalton as the instructor in practical telegraphy, and Mr. A. P. Chattock, member of the Physical Society of London, as the theoretical instructor. In order to supply the requisite instruction and training to persons intending to follow the profession of telegraphy, classes have been instituted at the above school, where such persons may obtain a practical knowledge of the nature and construction of the instruments now in use, a thorough training in their manipulation and in the transmission of telegraphic messages, with a sufficient grounding in such branches of electrical science as bear upon the subject of telegraphy. The course of tuition includes instruction in the working of the Morse printer, the sounder, the single needle, the mirror, and the syphon recorder systems. Experimental instruction is also given in the fundamental laws of electricity and magnetism, in electrical testing, and in the various electrical measurements, and in such branches of mathematics and physics as are incidental thereto. In addition to this students are instructed in the principle and arrangement of the different instruments and systems used in telegraphy. Experience has proved that the most effectual method of acquiring proficiency in scientific knowledge is for the student to conduct his own experiments under the supervision of the teacher, as by this means the methods of experiment, arrangement of apparatus, &c., not only become impressed upon his mind, but he is able to pay special attention to those branches of the subject with which he is least acquainted. This principle has been adopted by the promoters of the new establishment.

BUILDING TRADES EXHIBITION. — This exhibition was opened in the Agricultural Hall, Islington, on Monday, the 16th inst., and will remain open until the 28th. As at several trade exhibitions held lately at this hall, there is an attempt—very good as far as it goes—at electric lighting. Messrs. Gretton, Mynn, and Co., of Grocers' Hall-court, E.C., supply several exhibitors with about 150 incandescent lamps of 20 actual candle-power. These are the Grubbe lamps, made by the Electric Manufacturing Company, and now exhibited for the first time. They are five inches long, with the carbon filament simply bent double without any coil or twist. The first two days they were maintained by a Gramme dynamo; but Grubbe and Benson machines were afterwards substituted, which are also to give current to a Phillips arc lamp, which is independent of springs and mechanism. It is a common fault with electrical indicators that the inefficient pivoting of the armature, or of the pin on which it plays, causes a sluggish action. This makes too great a demand upon the battery; and it frequently happens that the bell rings, while the visible signal is not made. Mr. George Porter, of Cullum-street, E.C., has overcome this difficulty in his patent indicator, by sending the current first through the electro-magnet working the visible signal, which, in falling, makes a contact, sending the current through the bell circuit. It is claimed that, with this arrangement, a battery of only half the usual power is required. He also shows in action a combined electric and pneumatic bell-call. The push works a piston in a small metallic tube, and forms electrical contact, sending the current through the electro-magnet, and causing the bell to ring as long as the finger is kept on the push. Messrs. Eck, Callow, and Co., of Dean-street, W.C., and Clerkenwell, exhibited, among a great variety of electrical appliances, a perfectly new electric lamp-lighter, independent of a battery and also of revolving mechanism. Two new gas engines are shown, in both of which there is an impulse at each revolution. One, vertical, designed by F. W. Turner, the father of the original Otto engine, has two slide valves for distributing the gas and igniting it, worked by separate excentrics, thus dispensing with springs and the objectionable catch levers formerly used, and ensuring a smooth and positive action of the valves. The 1 horse-power nominal, or 1½ actual, consumes only 45 cubic feet of gas per horse-power per hour, and the cylinder is kept cool by a stream of water, which affords a hot water supply. J. E. H. Andrew and Co., of London and Stockport, show their new horizontal "Stockport" engine, which has a separate cylinder for compressing the charge of gas and air before ignition.

THE ELECTRIC LIGHTING OF THE PADDINGTON STATION.—We extract the following from the *Journal of Gas Lighting, &c.*:—"The Telegraph Construction and Maintenance Company have paid 20 per cent. for the past year. This is an indication of the profit that is to be gathered from some branches of electrical work. In addition to their ordinary business, however, the latter company are doing something in electric lighting, upon the system designed by Mr. J. E. H. Gordon. They are laying down an installation for lighting the Paddington Station of the Great Western Railway Company—a work which the chairman (Sir Daniel Gooch), who happens to hold the same position in both the telegraph and the railway companies, confesses has 'taken much longer than he had expected.' Translated into unofficial language, this admission probably means also that it has cost more money than was anticipated. It was declared, however, that the lighting o

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this railway station is only a gigantic experiment for enabling the company to obtain the necessary experience for undertaking the lighting, in a similar way, of the parish of St. James, for which the company hold a provisional order. At the shareholders' meeting a question was put across the table with the object of eliciting what the Board really think of their Paddington experiment; and the chairman boldly confessed that it would be a loss. He maintained, however, that the lighting would be a success, and that the cost of it would not be altogether wasted, since it would show the Board exactly how they stood in respect of a large undertaking. It might be supposed that after all the lighting of a railway station, however large, with all the offices, &c., under one roof, and a trained staff always at hand to see and correct everything that goes wrong, is not quite the same thing as the house-to-house lighting of a London district, even in a technical sense. Commercially, the difference is immense. At Paddington the full consumption may be entered upon directly the installation can be got to work. There will be no waiting for patronage, with machinery and plant capable of supplying 20,000 lamps constantly going to supply one-tenth of the number." As a matter of fact the installation referred to is little more than in projection. Nothing whatever is known about it, even by the electricians of the company themselves. Our contemporary is naturally anxious, in the interests of gas lighting, to pass strictures even upon what is palpably incomplete; and remorselessly takes advantage of the admission of Sir Daniel Gooch that the work might be conducted upon an experimental basis rather than a commercial one. The explanation, however, of our contemporary's animadversion is to be found in the uncertainty which surrounds this installation. It is not often that so favourable an opportunity occurs for speculative reasoning into which bias can enter without fear of immediate contradiction.

Laying First Rail of the Blackpool Electric Tramway.—The first rail of the Blackpool Electric Tramway was laid on the morning of the 12th inst. by Alderman M'Naughtan, who, having completed the task assigned to him, said he had great pleasure in laying the first rail of the Blackpool new tramways. It was fortunate for them that the matter had been delayed so long, for had the trams been laid years ago they might not have been in the splendid position which they occupied that day. They would probably have had either the ancient horses, or steam, and they were all perfectly aware of the dangers from accident which attended both of those means of propulsion. They had now been enabled to avail themselves of one of nature's most wonderful, immense, and mysterious agencies—electricity. He trusted that the adoption of electricity would be a great success, for if so, it would be an immense attraction to Blackpool. Mr. Holroyd Smith, the lessee and engineer, then explained the purpose of an "insulator," which he afterwards attached to the rails. As long as he lived, he said, he would remember that act, because he felt that it was an act of importance not only to him as an individual but to a large number of people whose confidence in himself had been manifested so strongly. The little act was important, because upon it hung strange issues, viz., this line when laid would be the first in the world which was worked safely in public streets by electricity. He felt that not only did his own reputation hang upon it, but he had also upon him in some degree the reputation of this thriving town. Not only that, but his scheme was being steadily and critically watched by many important electricians. He wished to thank the company who had given him their support, and if they wished he would give them full details of the working of this scheme, which he might say had been inspected by Messrs. Siemens and others equally capable of judging of its merits, and they all expressed themselves in favourable terms. Councillor Bickerstaffe said they knew he did everything in the interests of the town, and it was principally through his instrumentality that they got their magnificent electric light. That, he believed, was money well spent, as the light was acknowledged to be the best in the kingdom, and was undoubtedly a great source of attraction. This tramway quite eclipsed anything that had yet been attempted in the point of attraction to Blackpool, and would, he believed, be the means of bringing thousands to the town.—Councillor Broadbent said they intended to have the whole of the line complete by Whit Saturday. Carriages had been ordered and would be in Blackpool in a month's time, and he felt confident that the line would be completed by then. The Corporation have entered into an agreement with a company (capital £25,000, which has already been all taken up) which will lease the tramways and pay the Corporation 6½ per cent. per annum on the total outlay, besides keeping the roadway over which the line passes in repair. The company, with which Mr. Smith, is identified, provide the electric apparatus and everything necessary for the proper working of the tramway. Mr. Joseph Copley, of Lincoln, is the contractor under the Corporation, for the laying down of the line.

The New Orleans Exhibition.—The Exhibition buildings and grounds are open till 10 p.m., and the visiting throngs witness such a flood of electric light as has never been seen before. Over 7,000 electric lamps (arc and incandescent) continue the illuminating contract when the sun goes down. The Louisiana Electric Company has been very busy, and but two or three of its thirty-five dynamos remain to be put up. The South Western Brush Company is now running under full head of steam. Five 65-light machines furnish 300 lamps to the Government building and a few to the grounds. The Jenney Company has its groups of ten lamps hung in mid-air, as they appear to be, and are certainly attracting considerable public attention. The plant consists of three each 30 and 15-light machines now running, and two more 30-light to be put in. They furnish 66 lamps to the stock barns, 29 to the waggon building, 8 to some of the walks in the grounds, and 15 to the Grand Rapids Furniture Pavilion. In addition to the above, one Jenney lamp will be placed on the steamboat landing and two in the waterworks building. The Thomson-Houston Company has two 30-light Machines in main building, running in connection with four like dynamos placed in Machinery annexe, from which are wired 75 lamps in Horticultural hall, 23 in saw mill building and 25 in the annexe itself. Besides, they drive four Cleveland motors used by H. Muhr Sons, of Philadelphia, who manufacture souvenir gold rings. They are the only electric motors (the Daft Railway excepted) so far observed in use in the Exhibition. An Edgerton motor, on exhibition, running a sewing machine is also run by this company. The Edison Company has excellently situated space, from the centre of which rises a group of coloured lamps, producing a pleasing effect. Beneath, and under the shadow of its support, hangs a drop light, bringing out in perfect relief the various colours in a piece of patch-work placed below. A case of lamps ranging from one to 100 candle-power, a sample of each of the fifteen sizes of wires used in lighting the Art Gallery; a picture of the "Pilgrim," bearing the legend that she is the largest steamboat in the world, and carries the largest electric light plant afloat (960 lamps); a few sections of underground conduits, a motor and fan, and an armature—this about constitutes the Edison Company's display. The Jenney Company near by displays a

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large case of Wallace diamond carbons of great variety of sizes, and a miniature star tower upon the top of which are to be placed three Edison incandescent lamps. The Thomson-Houston Company exhibit a number of arc lamps of different mechanical arrangements. A tastfully arranged little office shows the Thomson incandescent lamp to advantage. Among other things, the Roebling Company display hard-drawn copper and also galvanised wire for electrical uses. The American Electrical Works of Providence show a great variety of insulated and lead-covered wires, telephone cords, and aerial cables. Bare wires, both copper and galvanised iron, enter into the very complete exhibit of the Washburn and Moen Company. A thermostat, as simple as it is novel, and an electric bell, with constant ringing attachment, together form a local fire alarm system, and is the electrical contribution of New Orleans to the Exhibition. Electrically speaking, the golden glory of the Music Hall, as seen from its main entrance, and the silvery beauty of Horticultural Hall, viewed from a distance, divide the honours (at night) of the Exhibition, although the electric railway connecting the Government and main buildings, the track being some 1,100 feet in length, commands no small share of public attention. The equipment consists of a Daft dynamo in the main building, a motor, and three cars. The "electric glide," as a trip over this, the first railway of its kind in the south, is called, is now one of the features of the Exhibition."

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—We have been favoured with the first volume of the *Transactions* of the above-named Institute, which, it will be remembered, was formed in May last. It has now a membership of 300, and bears good promise for the future. We abstract the following portion of a paper, by T. D. Lockwood, upon "Earth Wires; or, the Earth as an Electric Circuit Completer":—"The first instance on record, where the earth or a portion thereof, in the form of water, was used deliberately, as an electrical conductor, to complete an electrical circuit, dates back to July, 1746, when Winkler, of Leipsic, both charged and discharged a battery of three Leyden jars through an insulated wire 37½ yards long, the wire being laid along the bank of the River Pleisse, the waters of which constituted the return part of the circuit. Winkler ascertained by this experiment that the effects of the discharge were not perceptibly different from those observed when a metal discharging rod was used. About the same time Le Monnier, of Paris, made similar experiments, and discharged Leyden jars through the water of a tank in the garden of the Tuileries. We find from Priestley's 'History of Electricity,' that in England, shortly after the above experiments, Dr. William Watson carried out a number of others in the same line, under the auspices of the Royal Society Committee. On the 14th and 18th of July, 1747, the first experiments were made, a wire being carried over the River Thames on Westminster Bridge, the water of the river serving as a return path for the current. On the 24th of the same month, a similar trial was made in a circuit of two miles, at the New River, near London. Two trials were here made; in one of these the electricity successfully traversed a distance of 800ft. overland, and 2,000ft. by water; and in the other the circuit comprised 2,800ft. of land and 8,000ft. of water. In August of the same year it was discovered by Watson that dry ground conducted the subtle force quite as well as water. Again, on August 14th, 1747, at Shooters' Hill, a circuit was experimented with, consisting of two miles of wire and two miles of dry ground. In all of the above trials the electricity was effectually conducted by the earth acting practically as a return circuit. Finally, in 1748 and 1749, these results were verified by Franklin and De Luc. We may note here, by the way, that nearly all of the early proposers or devisers of early electric telegraphs, from Le Sage down to Dyer, had intended to employ the earth as a return. It is also, however, to be remarked that all of the above instances were experiments with high tension electricity; and that thus, if there had been no examples in which voltaic circuits had been completed through the earth, our fathers might have been excused in waiting for Steinheil. But such examples are not wanting, and the conductibility of the earth with respect to chemically-generated electricity was also known for a long time anterior to Steinheil. In February, in 1803, Aldini sent a current from a battery of 80 silver and zinc plates from one side of Calais harbour to the other through a wire supported on masts, the return being through 200ft. of water. He also repeated the same experiment at Paris and Alford, using the Rivers Seine and Marne. Basse, of Hameln, in the same year made a series of experiments by which he fully established the fact that the earth could be used as a part of a voltaic circuit. Erman, of Potsdam, somewhat later, verified these results in the waters of the Hamel; and eight years later (1811) Soemmering and Schilling performed almost identical experiments with a view to establish the feasibility of using the earth as part of any electric circuit. These are the historical circumstances which form a basis for the present system of earth completed circuits; and we may clearly see that as early as the beginning of this century the fact that the substance of the earth in the form either of water or dry ground could be used as part of an electric circuit was well established. In view of these circumstances, it seems very strange that the earth circuit was not used, or even with one exception proposed, for telegraphs, until used by Steinheil in 1838. It is rather difficult to see why a well settled knowledge of the above circumstances which, if acted upon, would at once have halved the number of wires required, was not utilised until so late, even by Schilling and Soemmering, who were two of the earliest telegraphic inventors, and who both, although instrumental in demonstrating the truth by experiment, failed to apply it to their telegraph system. Steinheil's idea to use the earth as a return was in a measure forced upon him, being an observation made of the result of an experiment tried for quite another purpose. Singularly enough, his discovery was foreshadowed in a letter signed 'Corpusculum,' dated December 8th, 1837, and published in the *Mechanic's Magazine*. This letter speaks of the numerous designs for telegraphs, which were then being brought forward, and says that he, too, formed one, and prepared a specification for it, five years ago, including a plan of making one wire only serve for the return circuit for all the rest . . . ; '*but even that*,' he goes on to say, '*might I think be dispensed with, where a good discharging train, as gas or water pipes, at each end of the telegraph could be obtained.*' The *application* of the earth itself, as a return, and a *common* return circuit for telegraph wires, came about in this way:—Professor C. A. Steinheil, of Munich, had in the year 1836-37 constructed a telegraph line, and devised a most ingenious system of operation for the same. In consequence of a suggestion made by Counsellor Gauss, that the two rails of a railway might be used as conductors for the electric telegraph, Professor Steinheil, in 1838, tried the experiment on the railroad between Nurnberg and Fuerth. He was, however, unable to insulate the rails properly, and he found that the electricity passed from one rail to the other through the earth. He then used one rail as the return wire, the direct line being an insulated wire, and found it to work perfectly, for the rail itself acted not only as a return but also as an earth plate. Subsequently he discarded the rail, and substituted earth plates at both ends.

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ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 347.)

The current flowing through R in Fig. 2 will be the greater the more cells are employed, the higher the electromotive force and the smaller the internal resistance of each cell; and also the smaller the resistance of the loop wire r. Of these conditions that of minimum internal resistance will evidently be most conducive to economy. To obtain it we must employ battery plates of large surface and a stout wire for the loop r; we must also arrange the plates as near together as possible, thus making the battery short. In the magnet (Fig. 3) a maximum of lines will be obtained, the greater the total exciting power (number of cells), the more ampere-turns we get on to the magnet per lineal inch (electromotive force of one cell), the larger the area of core (resistance of one cell), and the heavier the yoke (stout loop wire r). It will also be advantageous to make the magnets short, which corresponds to the shortening of the battery, by arranging the plates as near each other as possible. In this respect, however, there is a limit. In the first place a certain length of core is necessary in order to get the required amount of copper wire on; and, in the second place the leak of lines would be unduly increased by making the magnets too short. In the battery the path of the current is well defined; it has to circulate round this path, and no part of the current can take a short cut across from one row of cells to the other unless a conductor is provided. With our magnets the case is different. The lines can take a short cut from one arm to the other, since air, or any other medium, acts to a certain extent as a conductor for magnetic lines of force. To maintain the analogy with the battery we

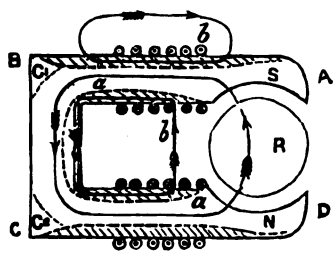

FIG. 4.

must suppose the same to be submerged in water or other imperfectly conducting medium, if such a thing were possible without spoiling the cells. For argument's sake, suppose it to possible, and see what happens. An intricate system of currents will flow in all possible directions, but always from places of higher to places of lower potential. This leak of current will be the more serious the smaller the distance between points of greatly varying potentials and the larger the surfaces of leak. The shorter the battery and the larger the plates the more current will be wasted laterally, and consequently there exists a limit beyond which a reduction of internal resistance would do more harm than good. The current leaking out laterally monopolises a certain portion of the surface of the plates, leaving the remainder for the passage of the current, which does useful work in R, and so it comes that the greater the leak the less useful current can be obtained.

We may regard our electro-magnet as such a battery submerged in an imperfectly conducting liquid, in this case air. Let in Fig. 4 A B C D be the magnet with armature R interposed between the poles S N and traversed by lines, one of which is shown at $a\,a$. These we may call the useful lines. They are due to the internal wires (marked with a cross) in which the current flows towards the observer. Besides these useful lines the current also produces useless lines, $b\,b$, some of which are due to the internal wires, and run across from one arm to the other; and others, which are due to the external wires and run longitudinally from end to end on each arm of the horseshoe, as shown. Evidently, these useless lines must be accommodated somehow within the core of the magnet, and they monopolise part of the cross sectional area. To make this plain in the sketch, the space which we imagine to be required for these lines $b\,b$ has been shaded. In this way the space at the disposal of the useful lines is somewhat reduced, and the general effect is the same as if through the reduction of cross sectional area the magnetic resistance had been increased. How much increased depends on the arrangement of the magnet. The core should not be too short, and the two arms should not be too near each other; there should also not be any projecting points which would shorten the path of the lines b through the air. At one time it was thought that huge pole pieces, as shown in Fig. 5, would greatly improve the machine. At the same time the yoke was extended so as to come beyond the exciting coils, and thus an easy and pleasant path was created for the useless lines to the detriment of the useful ones. For the rest, all sharp corners should be avoided, and the form of magnets shown in Fig. 4, although very superior to Fig. 5, could still be improved by rounding off the corners C_1 and C_2.

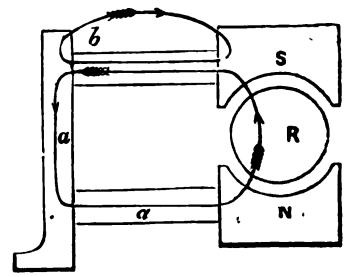

FIG. 5.

It might be asked how the loss of conducting power of the magnet core consequent upon the leak could be calculated? The author is bound to confess that he does not know how to do it with any pretence to accuracy, and has never attempted it, since in practice, and especially with modern dynamos, the number of lines wasted by leakage is very small as compared to the number of useful lines. However, a formula will be given below for finding the magnetic resistance of the air space between the polar surface and external surface of armature-core. Supposing the formula to be applicable to cases where the surfaces are not opposite and near each other, then the magnetic resistance of the air surrounding the magnets could, with a good deal of trouble, be calculated approximately, and from it the number of leaking lines could be estimated.

Referring once more to Fig. 4, it will be seen that the useful lines $a\,a$ are entirely due to the inner wires, and that the outer wires not only contribute nothing to these lines, but, by creating a leak, reduce the available cross section of the magnet core, and thus are, to a slight degree, detrimental to

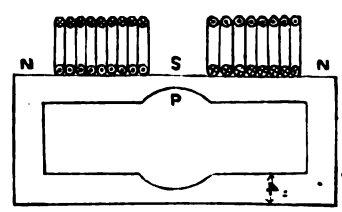

FIG. 6.

the working of the machine. By no possibility can a line of force belonging to one of the external wires go through the armature. This follows from the fundamental conception that each line must be a closed curve surrounding its wire, and it would hardly require further proof. But to exclude all possibility of error the author has made the following experiment, to show that the external layers on a horseshoe magnet contribute nothing to the strength of the field, although they make the external surfaces of the pole pieces strongly magnetic. The wrought-iron carcass of a dynamo was used for the experiment. It consisted of a double horseshoe, composed of straight slabs 4in. by 15in. in cross section, having polar cavities bored out in the middle, as shown in Fig. 6. Flat coils were placed on top, and so connected that the current flowed from the observer in those wires, which were close to the iron on the left, and towards the observer in the wires to the right.

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The current in the top layer of each coil flows, of course, in an opposite direction, but as these are comparatively far from the iron, their influence on the core is much less and, as was to be expected, the differential effect of the near and far layers was evidenced by strong magnetism in the points N S and N. But in the polar cavity at P not a trace of magnetism could be found. The question now presents itself, whether it be not possible to construct a dynamo without any wire on the outside of the horseshoe. The advantage of such a machine would not only be a saving of wire but also a saving of iron, because the absence of external lines would admit of using a core of smaller cross-sectional area. This problem is, however, not an easy one, and for two-pole machines it has, as far as the author knows, only been solved in one single case. The difficulty lies in this, that the current has to be led in the same direction on both arms of the horseshoe, and it is only in the Hochhausen machine (Fig. 7) that this condition has been fulfilled, at least partially, by the device of exciting only one of the arms of each horseshoe. The machine can be considered to consist of four horseshoe magnets N A B C, N A H G, S E D C, and S E F G. Only the arms N A and S E are directly excited, whilst the other arms, being farther removed from the

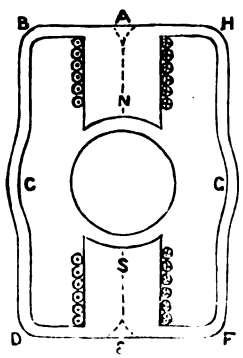

Fig. 7.

coils, are themselves only slightly excited, but serve the purpose of conducting the lines from E to A, in the same way as the yoke in an ordinary horseshoe. From what was said above, it will be seen that this machine could be improved by making these conducting pieces much heavier, than shown in the sketch.

In four-pole machines the problem of avoiding waste wire is solved without difficulty. One method (as far as the author knows not yet tried in practice) is shown in Fig. 8. Only two coils, *a a* and *b b*, are used, filling completely the shaded space shown in the sketch. The direction of the current in each space is indicated by the little circle with a dot or a cross, and it will be seen that four poles, N S N S are thus produced.

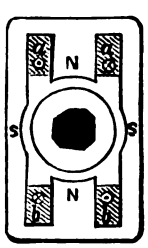

Fig. 8.

The only waste wire, and that only partially wasted, will be at the ends in front and at the back of the machine. From a practical point of view, this arrangement of field has also the advantage that the whole of the carcass could be cast in one solid piece, the central space required for the armature being large enough to allow the introduction of the coils. Against this it must, however, be urged that the days of cast iron as a material for magnet cores are nearly over, and therefore this advantage of simplicity is hardly worth considering. The arrangement seems, nevertheless, worth a trial on account of its cheapness and compact form.

Another method of avoiding waste wire has been adopted in machines made by Gramme, Varley, and others, and is shown in Fig. 9. The advantage of this arrangement over Fig. 8 is that, in consequence of a perfectly symmetrical dispositions the same number of lines emanate from each pole, and thus entire freedom from sparking at the brushes is insured, a point which in the previous arrangement is somewhat doubtful.

Before leaving the subject of waste wire it will be necessary to consider whether the wire joining the inner and outer layers of each coil contribute anything to the useful lines. If we imagine for a moment the field-magnet and armature to be of wood or other non-magnetic substance, the lines round this part of the coil would be curves lying in planes parallel to the axis of the armature, and either missing the latter altogether, or, if they cut it, entering and leaving on the same side, and therefore not contributing anything to the electromotive force. But since the core, pole-piece, and armature are made of iron, these lines will be no longer plane curves, but as shown at the beginning of these articles, curves of three dimensions. Then we found that the curves can be deflected up to an angle of 90°, although the more their deflection approaches this limit the weaker do they become. If we now arrange the carcass of our field magnet in such a way that the length of pole piece and armature measured parallel to the axis is somewhat greater than the width of the magnet core measured in the same direction, the lines belonging to the wire at either end can still reach and go across the armature, their distortion being less than 90°. The wire joining the inner and outer layers on each magnet core is therefore not totally wasted; it does contribute to some extent to the production of useful lines, although not so effectively as the inner wire.

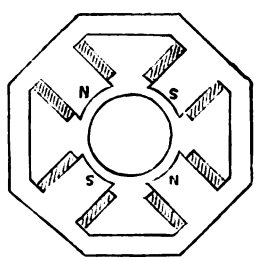

Fig. 9.

In disc machines, where the magnet cores are arranged parallel to the axis, there is also some waste wire, as can easily be seen by drawing a front view of the disc with the magnet cores in cross section and excluding all the lines as impossible, which would have to be distorted through an angle greater than 90°. It will then be seen that with circular cores one-half the wire is wasted in two-pole machines, and one-quarter the wire is wasted in four-pole machines.

(TO BE CONTINUED.)

THE BIRTHPLACE OF THE TELEPHONE IN ENGLAND.

Beyond the limits of a circle of scientific men, enthusiasts, and editors of newspapers, who know, or who are supposed to know, everything, the telephone, for an instrument of such wide utility, is but little understood. The reason for this is perhaps not hard to find. In all probability no other appliance, mechanical or electrical, has been the subject of so much litigation, is more thoroughly hidden, more jealously guarded by monopolists, or under more restrictions than the apparatus commonly included under the heading of "the telephone." Since it was given to the world in its rudimentary form the information afforded to the public with regard to it has been almost purely theoretical in its character. At the present time the monopoly enjoyed by the telephone companies has placed a prohibitive duty upon economical experiment. The telephones and microphones of to-day are inaccessible to those who have the command of but moderate means. They cannot be purchased in England, nor are they procurable for purposes of experiment, except upon the payment of a heavy royalty; or of a subscription which merely entitles the subscriber to have the limited use of one set of apparatus.

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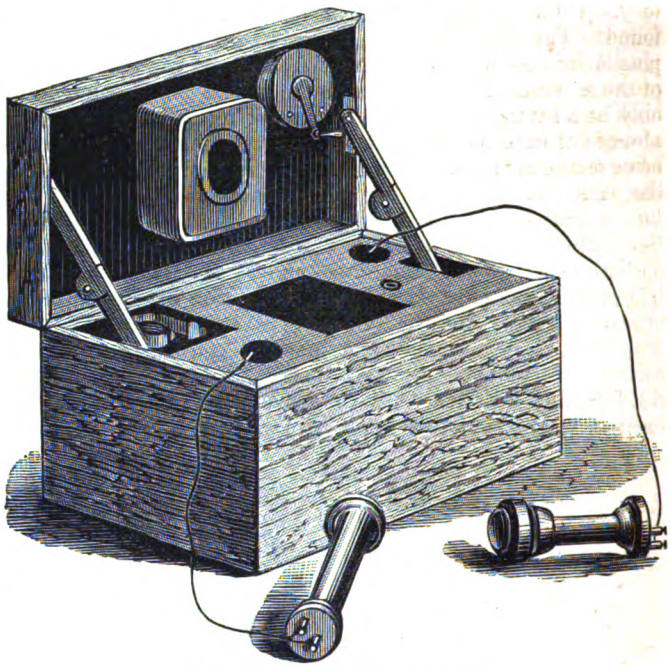
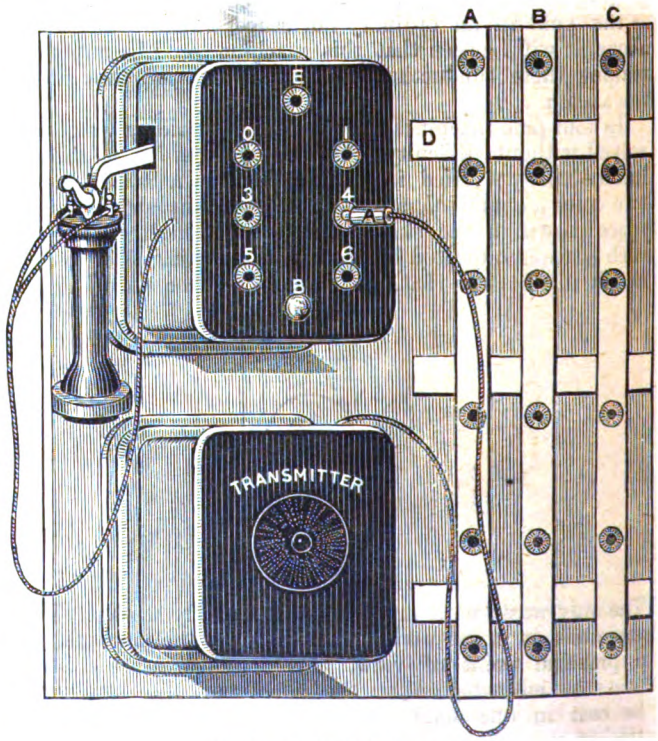
Under such circumstances it is not surprising that so little real knowledge of the actual constitution of the telephone exists. The restrictions are no doubt necessary. Invention should be protected and encouraged. We can only lament that as a consequence a tax is indirectly imposed upon anything like extensive research. During the past week we were enabled by the courtesy of Mr. Charles Curtoys, the secretary of the Consolidated Telephone Construction and Maintenance Company, to pay a visit to what may not improperly be called the birthplace of the telephone in England, in that at the company's works in the Farringdon-road the telephone industry is more largely represented than in any other manufactory in the United Kingdom. Thanks also to Mr. Mason, the general manager, who was our cicerone on the occasion, and who made our visit a very interesting and a very instructive one, we had the opportunity of inspecting some really first-class machinery, and of entering into all the details of telephone construction. On the ground floor of the premises is the machine room, in which, in addition to a number of lathes, drill presses, &c., and a whole host of tools of every sort, size, and description, we noticed, as exhibiting perfection both in design and workmanship, two screw-making machines, capable of manufacturing from 1,000 to 1,500 screws or terminals per diem; one making 4,000 to 5,000 small screws per diem; an automatic punch press to make 90 blanks up to 6in. in diameter per minute; a punch press making 150 blanks per minute; an automatic tapping machine tapping from 30 to 50 holes per minute; and a universal index milling and gear cutting machine which seemed to be capable of making almost anything, from a toothpick to the most complicated forms of spiral gear. There, also, were horseshoe magnets for the magneto bells undergoing saturation at the rate of about two per minute, the current being supplied by an Edison Z dynamo, driven by a 60 horse-power Gwynne horizontal engine, which also serves six Thornton arc lights on the lower floor, and 220 twelve candle-power Edison incandescent lamps throughout the building. Another feature of interest was the process of depositing brass upon iron by electricity. We understand that the method is not very generally known. We can, however, testify to the excellence of the imitation, and the neat appearance of the screws and other constituent parts of the apparatus which were so treated. On the first floor we were shown the fitting room, where the thousand or more parts of the telephone, magneto-bell, and transmitter, were being pieced together by boys. This is but a simple operation, in that all the component parts are so accurately made by machinery, are so mathematically exact in their proportions, and therefore fit so easily in their respective places, that their combination is a mechanical operation calling for the display of no other quality than that of attention. At a centre table was a member of the fair sex winding the coils of a magneto bell, an instrument capable of ringing through 30,000 ohms resistance; at others were skilled workmen soldering the platinum contacts to delicate springs, &c., while on every side were to be seen, in various stages of completion, large numbers of the Gower-Bell and almost every other form of telephonic apparatus which has successfully withstood the test of our time. One very ingenious, and, we think, very useful, contrivance, to which we especially directed our attention, was the telephone apparatus for the use of divers. Without doubt, in diving operations the telephone forms a very important addition to the equipment of a diver. It gives him a means to communicate with those on the surface of the water, and by this means he is able to make known his wants, and to receive more prompt assistance in the case of danger. The apparatus consists of a cap, to which is fitted two telephone receivers; this cap is fitted to the diver's head, and the receivers are arranged to cover the ears. The cap is secured by means of a strap and buckle, and the diver's helmet is then placed over the head, but before being secured, a connection piece, which is attached to a flexible cord, is placed in a socket at the side of the cap; this connecting piece and cord is in communication with a magneto-transmitter fitted into the side of the helmet. The telephone for use on the surface is contained in a strong wood box, and consists of a carbon transmitter, a switch (which is used to connect the battery to the transmitter), and two telephone receivers, one of these being placed to each ear. A cable with an insulated electrical conductor inside is used to connect the instrument used by the diver and the instruments on the surface.



Telephone Apparatus for Divers.

Amongst the other apparatus which we had the pleasure of inspecting was the Domestic telephone, and a Public telephone for police, fire alarm, and other purposes. The former provides for a means of telephonic communication between rooms or departments of public or private houses, having at the same time an independent connection by private wire with a central



The Domestic Telephone.

exchange system. The arrangement of wire and the mode of operation are very simple. In a house of eight rooms, for example, an instrument is placed in each room, and wires, either separate or in a cable, are then run from No. 1 room to No. 8 room, each of the wires being numbered; these wires

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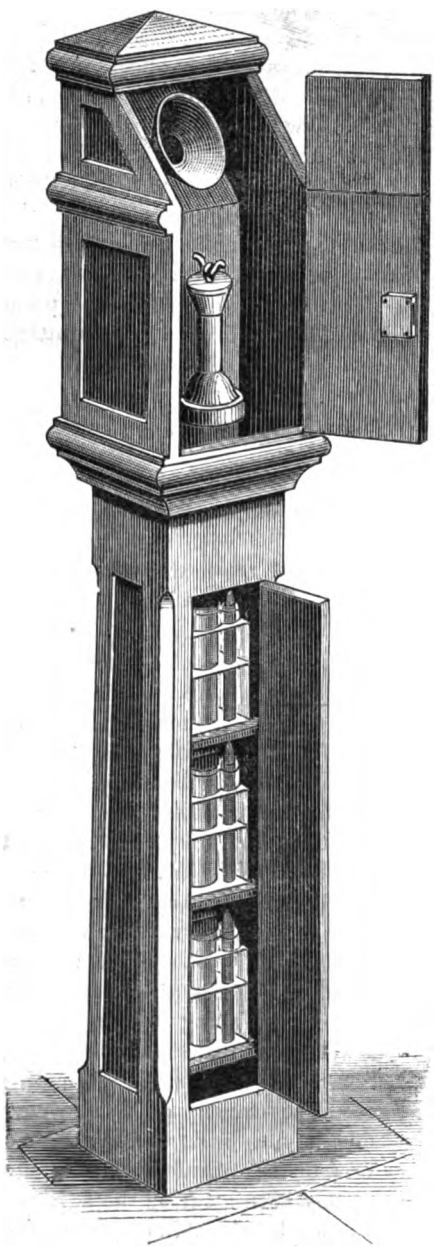
are then connected to their respective numbers on the instruments—that is, No. 1 connected to the zero of No. 1 instrument, and to the No. 1 socket of all the other instruments. The battery and earth wires are included in the system and connected to all the instruments, thereby requiring one battery only for the entire system. The mode of operation is as follows: Say No. 1 wants to speak to No. 4, he will insert the plug A into socket 4, the act of inserting the plug with slight pressure rings No. 4 bell; then take the telephone from its hook and listen. No. 4 will then have inserted his plug in the zero of his instrument to ask what is wanted. Communication being thus established, one can ring off by again slightly pressing the plug. It is not necessary to remove the plug until a call



The Public Telephone.

is received or it is wished to call; in fact, it makes no difference whether the plug is in or out of one of the sockets; or if the telephone is off or on the hook, the call can always be received; but when called it is necessary to insert the plug into zero and speak.

The socket E is intended to be connected by private wire to a central exchange system, and is so arranged that, by pressing the button B, the exchange may be called. A bell is also provided, so that the exchange may call the subscriber. To arrange this the plug A must be inserted into the socket E, and B be pressed; the telephone is then taken off its hook, and applied to the ear. When through, one can ring off by again pressing B. One great advantage of this is, supposing that there is but one private exchange wire included in a system of domestic apparatus, and that No. 4 should want to speak to the exchange, he could do this by calling up No. 1, and asking him to connect his wire through. No 1 would then insert two plugs, one in socket 4, the other in socket E, and ring No. 4, and the exchange then would be in circuit, and No. 1 would still be able to communicate to all others included in the domestic system. To extend the system it is only necessary to provide switches for the additional number of wires run, and to the original strips having sockets and battery connections, as A, B, C and D. The switch itself may be included within A transmitter, and with or without the zero and E socket. Strips similar in principle to A, B, C, carrying all of the wires.

The Public telephone, as shown by our illustration, is fixed on an ordinary street post, duly protected, and is placed in communication with any fire engine station, police station, or any other place required for communication, such as docks, &c. By means of an annunciator, placed in any selected spot, it is at once seen from whence the communication is coming, and by using the telephone, which can be placed under lock and key, for the use of subscribers, any necessary communication can be made. Such a telephone, if carried into extensive use, would prove of great service to the public in cases of emergency; keys might, for instance, be granted to anyone subscribing a moderate sum, so that a ready means of communication with the police, fire stations, or a central office might at all times be within reach. We should like to see them erected in all the principal thoroughfares of the metropolis, and the sooner the better, for everybody concerned.

Having thus reflected, we, under the friendly guidance of the energetic manager, ascended a labyrinth of staircases, and were at length confronted by a number of young people who were winding coils for the Gower-Bell and other telephones, and very expeditiously and very neatly they got through their task. In a small room close at hand a lad was testing the finished coils for resistance by means of a Wheatstone bridge and a tangent galvanometer. The limit of error allowed was, we were informed, about one per cent. on the rough test merely. In conclusion, we have to congratulate Mr. Curtoys upon the evidences of prosperity which were everywhere to be seen; and we advise those who have an hour or two to spare, which they would employ to good advantage, to pay a visit to the birthplace of the telephone.

THE INTERNATIONAL INVENTIONS EXHIBITION.

There are but few persons who went to the Fisheries and Health Exhibitions who will not remember the excellent manner in which those buildings were electrically lighted. The Executive Council have decided to light up the whole of the buildings of the Inventions Exhibition by this most excellent and best of all artificial lights, and the contract for supplying the whole of the motive power for driving the electric light machinery has been placed in the hands of Messrs. Davey, Paxman, and Co., engineers, of Colchester, who, it will be remembered, so successfully supplied the power at the two previous exhibitions. The plant (ten steam boilers and five powerful steam engines), as supplied by Messrs. Davey, Paxman, and Co. last year, is retained, and besides this eight additional large locomotive boilers will be provided by the same firm. These new boilers will all be made of best quality steel, and have all the most modern improvements. Each boiler will contain 610 square feet of heating surface, and these eight boilers, with easy firing, can evaporate 36,600lb. of water into steam per hour. The total number of boilers will be 18, so that 110,000lb. of water can be made into steam of 100lb. pressure per square inch per hour. It will thus be seen that an enormous amount of power is provided for the Executive Council by this firm, who we congratulate upon being again elected for this important undertaking.

PRIMERS OF ELECTRICITY.—These Primers (by Prof. Houston and others), which had a large sale at the recent Philadelphia Exhibition, can now be obtained at the office of *The Electrician*, price 1s. the set of twenty-seven.

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THE ELECTRICIAN.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

A PROPOSED NEW ELECTRIC LIGHTING ACT.

The Committee appointed by the Electric Lighting Corporations to consider the possibilities of amending the existing Act have promptly accepted the challenge to let the Board of Trade know exactly what the Corporations want; and, as we predicted at the time, they have seen no other way of usefully amending the obnoxious Act than by demanding the absolute repeal of the 27th clause. A thorough examination of the whole subject both for its immediate and future possibilities has shown the Committee, in fact, that the only way in which the promotion of Electric Lighting can be made practicable as a business concern is by placing it precisely on the same footing as that on which legislation of recent years has placed the gas light companies. The Committee have drawn up a Bill on this basis, and a deputation to back it up with arguments and facts is to seek a fresh interview with the President of the Board of Trade.

We print elsewhere the "Reasons" put forward by the Committee in support of the various provisions of the Bill as drafted by them. They will be seen to be eminently sound and reasonable. To our thinking they are unanswerable as touching the utterly objectionable character of the existing Act, and the necessity for its repeal. We have from the very first condemned that Act, and we do so still; and in so far as the present movement tends to get rid of it we are heartily in accord with the Committee. We are not quite sure that we are anxious to see that Act substituted by another, however harmless its provisions may be. We cannot entirely divest ourselves of apprehensions lest the mere fact of legislative sanction in a new form might have just the same effect that the first parliamentary essay of that kind had on public confidence—that is to say, it might give an unnatural impulse to company promoting, and an over-confident supply of capital on the part of the public, so that in a very short time there would be another series of collapses and a further shock to public confidence which might prove even more disastrous than the last. We want to see the electric light progressing by natural growth; we do not think it wants parliamentary help, nor that it would be any the worse for having no such help. By obtaining parliamentary recognition it acquires an artificial status which may be seductive to the public, and which may tempt the undertakers into enterprises beyond their present powers. A speculative era might set in which, although pecuniarily profitable to those immediately alive to its advantages, might do no permanent service, but rather the reverse, to the cause of Electric Lighting.

At the same time we are strongly in accord with the Committee in desiring the complete abrogation of the 27th clause—the clause which empowers the local authorities to buy up the undertaking at the end of twenty-one years. The newspapers have been too busy with urgent foreign affairs of late to bestow any attention on the proposed new Bill. But an evening contemporary which is always ready with a decisive opinion upon anything and everything on the shortest notice has in one short paragraph disposed of the Committee's labours. If, says the *Pall Mall Gazette*, the Committee imagines it is going to be allowed to set up a lot of monopolies without the option of local purchase, *it is greatly mistaken.* Now, if a monopoly were demanded without any obligations attached to it, the case would deserve to be dismissed in this off-hand fashion. But the would-be monopolists voluntarily assume all the obligations and responsibilities which pertain to monopolies in general and to those attached to gas-lighting monopolies in particular. Therefore, what our contemporary really means is that there shall be no more monopolists except such as can be extinguished by parochial vestries the moment the monopolies have become worth extinguishing by the process of expropriation from the hands of the undertakers to the hands of the parish. No reason is assigned for this astounding proposition, which has no precedent except the tramway companies, and this a very bad one, besides being one that has no resemblance to the industry now under consideration. The newspaper we are quoting has lately been assuring the British public night after night that the whole subject in dispute on the Afghanistan frontier is a piece of waste grass land and a wooden sentry-box. Similarly, the matter in dispute with the electric light promoters is one solely of monopoly. These positive misstatements, on the one hand, and suppression of facts on the other, are deliberately designed for misleading public opinion; and we connect them together in this relation to show the worthless character of criticism from such a quarter, able and influential as that quarter undoubtedly is.

The *Pall Mall*, we suspect, merely utters the shibboleth of a political party when it declares against the monopoly of private corporations. We want to know its objections. If it favours State socialism, the absorption of all public works by the State or the parish, let it say so. We, for our part, have no objec-

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tion. But we do strongly object to do all the dirty work for the State or the parish, and then to be sent about our business with empty pockets. We object to being treated as *primâ facie* public enemies, allowed to live only on sufferance, and to be gobbled up directly we are fat enough to be eaten. We decline to do all the experimental and hazardous preliminary work for the public, with nothing sure at the end of it but confiscation if we happen to be successful. Let the State take up the initial stages, and we will help it in every way we can to make the business succeed; but we flatly decline to run all the risks of a monopoly without enjoying any of its advantages.

The Committee have taken their stand on these sound principles and do not intend to depart from them. We do not think the Board of Trade will yield. Political fanaticism in that department is too thick skinned to be penetrable by sound argument or precepts of common honesty. The business of Electric Lighting is probably fated for some years to come to work on its own bottom in departments of activity where the State can neither harass nor confiscate it. On the whole we are not inclined to grieve on this account; on public grounds we certainly do lament the circumstance that a great public benefit has been hindered by what is nothing less than a mere political fad which happens to be in the ascendant just now. But in the long run perhaps the electric lighting promoters will be the gainers; and even now they have a wide field of operations open to them which, if diligently cultivated, will yield a profitable harvest in defiance of the existing Act of Parliament, and without the artificial help even of any new Act that the present Committee might approve of.

CORRESPONDENCE.

THF WIMSHURST ELECTRICAL INFLUENCE MACHINE, ELECTRICAL UNITS, &c.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is indeed a welcome, but infrequent, number of your journal that is distinguished by two letters so pregnant with the esoteric philosophy of electricity as the current impression.

It has been conjectured by those who have read between the lines of the latter pages of the history of dynamic electricity that the pioneers of dynamo design have been groping round the truth that centifrugal force is the radical cause of the electric current. The mere fact that in the older armatures there were many layers of wire, and that by degrees the depth has been decreased until one layer is found to be more than sufficient, is proof enough that it is not the wire, but the tangential inertia that polarises the commutator. It has been well known that boreal aurora is due to the axepetal tendency of equatorial E.M.F.

He was a bold man who first attempted to produce electric light at a distance by incandescence caused by the transmission of heat along the wire, for, as your correspondent writes, ordinary heat will not travel along a wire; but now, by producing disruptive deliquescence of the ether at the periphery of the rapidly-rotating armature, the decrystallising influence creates such intense cold that the inrush of radiant energy produces incandescence by the mere absence of cold at the remote end of the wire. The simple reason why this was not discovered before is that the ether is a perfect non-conductor of cold, which therefore could not be perceived. Hence the reason for applying sulphur to hot bearings.

Intimately connected with this is the relation of force and mass. For since force $= \frac{ML}{T^2}$ mass = force multiplied by the reciprocal of acceleration. Therefore, with the acceleration of the armature the E.M.F. varies inversely as the mass of copper on it. There is some substantial probability in this hypothesis, as it is supported by more than two experimenters' results. Should, however, the shellac become sticky, and therefore actually increase in weight under the strain of centrifugal force, the decrease of dielectric strength will tend to induce, or rather influence, a Peltier effect which may lead to sparking. This can be readily obviated by making the lead of the brushes a harmonic function of the mean radius of gyration of the switch handle.—Yours, &c. T.

A NEW INDUCTION TELEGRAPH.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to the account published in your issue of 7th inst., headed "A New Induction Telegraph," may I point out that this invention forms no exception to the old proverb relating to the majority of things under our sun.

In the absence of earlier dates, however, I may state that this system of communicating with moving trains by means of electrical induction, almost exactly as described, was invented by me as far back as 1881, and actually tried electrically far enough to prove its complete feasibility.

My object was chiefly to provide an efficient means of fog-signalling, by enabling the signalman to communicate directly with the drivers or guards of moving trains.

I proposed to run a wire along the permanent way, parallel with the rails, and to wind a coil of wire round the engine or carriage to be communicated with in such way as to get as long a length of wire parallel to, and as near to, the line-wire as possible, so as to be well exposed to the inductive action thereof, exactly as is now done. I then proposed to place in the signal-boxes a battery, signalling key, and rapid "make and break," or "buzzer," as your account calls it, and to thereby signal to the train, using a telephone on local circuit with the car-coil as a receiver. By using an ordinary carbon transmitter on direct circuit with the line wire, I also arranged and found it quite practicable to speak verbally to the train, so as to be heard distinctly in the telephone or telephones in the "car-coil" circuit.

This design was embodied in a paper which, in the year 1881, I laid before the managing director of the United Telephone Company. Want of time and opportunity alone has prevented it being put into practice. It was also tried practically at that time, using wire coils, properly proportioned in length, resistance, and distance apart to the conditions that would be obtained in practice. The trial was certainly not made on an actual moving engine, but the fact of the coils remaining stationary instead of moving could, of course, make no possible difference, since the speed of the fastest engine is practically *nil* compared to the rate at which the contiguous particles of a line wire are affected by an electric current, *i.e.*, the "speed" of the current. It has also been since simplified and arranged to produce both visible and audible signals on the engine or car by induction from a No. 8 iron line wire across a space of six inches, and using a current of only $\frac{1}{4}$ ampere, that is such as can easily be produced by the ordinary Daniell batteries used in railway work. The signals are also undisturbed by great vibration.

The possibility of communicating with moving trains by means of electrical induction was also suggested by Mr. Willoughby Smith in a paper read before the Society of Telegraph engineers last year, so that the principle can certainly not now be called new.—Yours, &c.,

A. C. BROWN.

11, Old Broad-street, London,
March 17, 1885.

THE SKRIVANOV BATTERY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you kindly inform me through your valuable columns:—

1st. In what proportions chloride of silver and the zinc plates should be used to produce the effect described in your issue of this day? 2nd. Where the battery could be obtained and the cost? 3rd. If it could be made in a more convenient

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form to fit the back? 4th. How long one charge will last, and the cost?

By so doing you would greatly oblige, yours, &c.,

A CONSTANT READER.

Newcastle-on-Tyne, March 14, 1885.

[We insert this letter although contrary to our usual course, the writer not having sent his name. A somewhat similar letter, also without name, has reached us from Edinburgh.—ED. *E.*]

THE COX-WALKER LAMPHOLDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly allow me space in your journal to hank Mr. Sydney F. Walker for his flattering referencc to the bove and our general work in your last week's issue?

His experience, too, as regards the fusing of the old "loops nd hooks" is very valuable evidence of the need of my new plan of making contact with the hooks, which will entirely prevent this fusing, so far as contact can do it; whereas, so long as two round wires at right angles are used for this purpose, the actual point of contact must be almost a mathematical one, and great resistance, loss of energy, and possible sparking the result.—Yours, &c., E. COX-WALKER.

March 16, 1885.

AN EARLY ELECTRO-MAGNETIC LOCOMOTIVE.

In the interesting account of electro-motors contained in a letter of Professor Moses G. Farmer to C. W. Field, and published in the *Scientific American* Supplement of January 17, there is a description of a small electro-magnetic locomotive, constructed in 1851 by Thomas Hall, of Boston, and which operated by an electric current conveyed by the rails, probably the first instance of an electro-locomotor deriving its

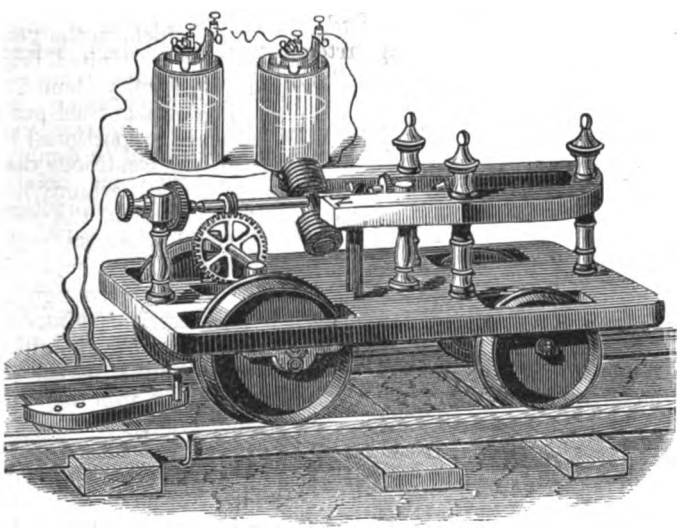

FIG. 1

actuating current from a stationary electric generator. This engine, with a part of its track, is represented in the accompanying cuts; it is owned by E. Dwight Kendall, consulting chemist, of Brooklyn, who purchased it, soon after it was made, of Daniel Davis, Mr. Hall's former employer. Professor Kendall occasionally used it in his lectures to illustrate electro-magnetic force.

The current of a battery or small dynamo electric machine is conveyed to the rails, the connections being made as shown in Fig. 1. The rear axle M (Fig. 2, being an inverted plan view of the locomotive) consists of a central wooden portion which is slotted to receive a standard projecting from a brass plate screwed to the bottom of the car. A bar connects the pivot pin with the shaft carrying the wheel K, which takes up the current from the rail; the other wheel, being insulated by the wooden portion, has no effect upon the current using the rail it runs upon. Both these wheels are loosely mounted. The current is led from the wheel K through pivot, brass standard, and wire to brass plate G. The front wheels are rigidly mounted upon an axle, at the centre of which is secured a gear wheel. One wheel is insulated from the axle by means of an ivory sleeve, L. The current passes from the rail through the wheel J, through the axle bearing and wire to a standard provided with a collar formed with an arm to which the lever A is fastened. This lever is insulated from the collar arm by a block of wood. Soldered to the rear end of the lever is a wire, one section, D, being always in contact with the plate G, and the other section, B, being turned and passed under the lever so as to rest in contact with plate E, which is one of a pair on the bottom of the car at each side of the standard. A wire, C, from the collar is in contact with plate F. By means of the lever, the pieces B and C can be brought in contact with either of the plates E and F. From the free end of the lever a short bar projects downward, so as to be struck and moved to one side or the other by the blocks H I, which are placed, one at each end of the track, at such an inclination as to move the lever sufficiently to change the plates with which the points B and C come in contact.

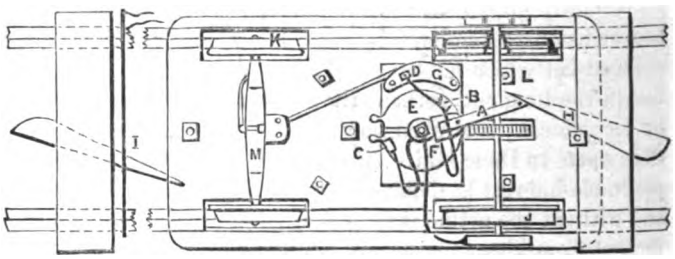

FIG. 2.

Mounted longitudinally upon the top of the platform is a shaft carrying an electro-magnet, revolving between the poles of a horseshoe magnet and a worm, which meshes with a gear wheel engaging with the wheel on a forward axle. The wires from the magnet lead to two semi-cylindrical pieces at the rear end of the shaft, against which press two springs connected respectively with the plates E and F. The path the current travels, when the lever is in either of its two positions, to revolve the magnet first in one direction, then in the other, will be understood from what we have said and from the engravings. With the current from two or three Grove or chromic acid cells the little locomotive exhibits great earnestness of purpose, and runs with respectable speed.

A RULE FOR RECOLLECTING THE DIRECTION IN WHICH A CURRENT IS INDUCED IN A CONDUCTOR WHEN MOVED IN A MAGNETIC FIELD.

BY DR. J. A. FLEMING.

Writers on electricity have given various rules for recollecting the direction of the current induced in a conductor when moved so as to cut lines of magnetic force and alter the amount of magnetic induction passing through the circuit. These rules depend generally on some association with the position and motion in swimming, or upon the direction of the cardinal points and the motion of the sun, earth, &c. Apart from the difficulty of recollecting the rules themselves, it requires an effort of imagination to apply them to the case of an armature, bar or wire, disc or loop, and as a means of economising time and brain labour I have found the following rule very useful for many years. Having recently given it to a class of engineering students, and finding it assist in thinking out various cases of induction, it is described here for the benefit of others.

If any circuit is being moved in a magnetic field, and it is required to know the direction in which electricity is being urged in any portion of the circuit which is cutting lines of force, proceed as follows:—Hold the first and middle fingers and thumb

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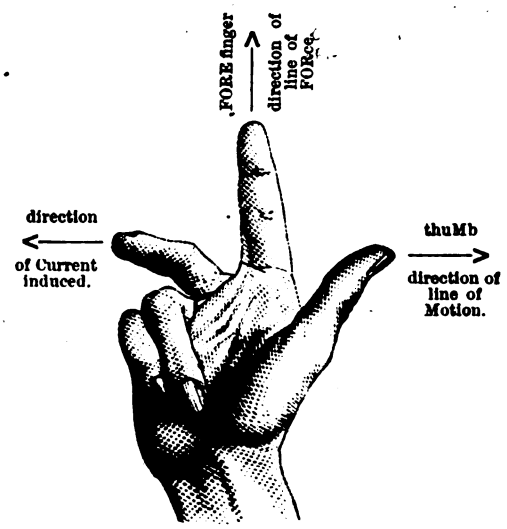
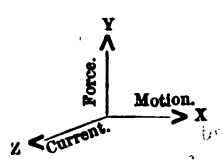
of the right hand in a position as nearly as possible at right angles to each other, so as to represent three co-ordinate axes in space. Make the following associations :—Let the direction of the fore finger represent the direction of the lines of Force (FORe and FORce). Let the direction of the thumb represent the direction at right angles to the direction of the field in which the element of the circuit is moving (thuMb and Motion), then the direction of the *middle finger* represents the direction of the induced current (Induced and mIddle). When once these links have been made, the directions of these three vectors will always remain related in the mind, and all that has to be done is to hold the right hand, with the fingers and thumb fixed in the position shown in the figure, and twist the

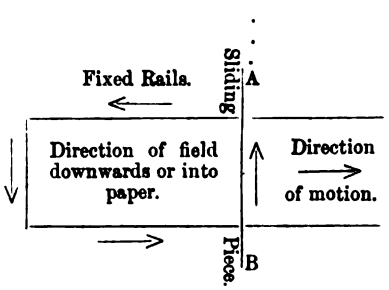


Right Hand.



Three axes at right angles, indicating respectively direction of line of Magnetic Force, Y, line of Motion of Conductor, X, and direction of current induced, Z.

hand about until the forefinger coincides with the direction of the field (which can always be ascertained by a pocket compass), and the thumb points in the direction of motion of the piece of the conductor considered (it will, of course, be in a tangential direction when considering a wire in a revolving armature), then, without any thought at all or references, either astronomical or natatory, the middle finger gives the direction of the actual or potential flow. A few simple cases considered, such as Faraday's copper disc between the poles of a horseshoe magnet, or the usual illustration of a pair of rails and sliding piece, will serve to fix the rule.



Take the case of a sliding piece slipping parallel to itself on a pair of conducting rails. Let the direction of the field be perpendicular to the plane of the paper, and let the lines of force run *from* the reader. Then applying the rule, it is instantaneously seen that the direction of the current is in the direction of the arrow marked along parallel to the sliding piece, and that the current circulates round counter-clockwise in the closed part of the circuit, when the sliding piece A B moves to the right. The rule is easily applied to all parts of the armature of dynamo machines. Now, let it be observed that in finding the direction of the current induced we use the right hand, but if we use the *left* hand instead, it provides a rule for determining the direction of motion of a conductor under the influence of a field when traversed by a current. The same associations are made for the three directions, but as by Lenz's law motion is opposite for same current or current opposite for the same motion, it is seen that the passage of a current creates a motion in the opposite direction to that motion which would have induced that current, because the left hand is the perverted image of the right hand. Hence we associate also *right* hand for *dynamos*, *left* hand for *motors*, directions of force, current, motion always in both cases indicated by the direction in which the fore finger, middle finger, and thumb respectively point.

UNDERGROUND WIRES IN AMERICA.

In Chicago there are laid down and in successful operation at present 718 miles of wire, of which the Bankers and Merchants' Telegraph Company own 400 miles; the Postal Telegraph Company, 150; the Chicago Telephone Company, 28; Western Indiana Railroad Company, 50; and the City and Fire Alarm Telegraph, 60. In addition to this, the Western Union will shortly have 500 miles down, and the Baltimore and Ohio 250, making a grand total of 1,468 miles of underground wires. A Bill is now being introduced in the House of Representatives at Harrisburg, U.S.A., which provides for a measure we hope to see made compulsory in this country before very long. The Bill is substantially as follows :—"1. Be it enacted, &c., that all telegraphic, telephonic, and electric light, wires, and cables used in any incorporated city of this commonwealth, having a population of 10,000 or more, shall hereafter be placed under the surface of the streets, lanes, and avenues of said city. 2. Every corporation, association, or person owning, controlling or operating telephonic, electric light or other wires and cables, including what is known as telegraph poles and other appurtenances thereto, shall, before the first day of December, 1885, have the same removed from the surface of all streets, lanes, or avenues in every such city of this commonwealth. 3. In case the owners of the property above enumerated still fail to comply with the provisions of this Act, within the time herein specified and limited, the local governments of the said cities of this commonwealth shall then, and they are hereby directed to remove, without delay, all telegraphic, telephonic, electric light and such other wires, cables, and poles, wherever found above ground, within the corporate limits of their respective cities. 4. No city in this commonwealth shall grant any exclusive privilege or franchise under this Act to any corporation or individual, by which a monopoly may be created or competition prevented on equal terms. 5. That any individual, firm, association, or corporation, or any officer, agent, or *employé* thereof, violating or failing to comply with the provisions of this Act, shall be deemed guilty of a misdemeanour, and, on conviction, shall be punished for each and every offence by a fine of 1,000 dols., one-half to be paid to the prosecutor and the other half to be paid to the county in which the conviction is had, and an imprisonment not exceeding two years, or either or both, at the discretion of the Court. 6. That all laws or parts of laws inconsistent herewith be and the same are hereby repealed."

SULPHUROUS ACID AND TELEGRAPH WIRES.—Between Lassale and Peru, in America, where the Central Union Company have several wires, there are several zinc furnaces in the immediate neighbourhood through which the lines pass. The fumes from these furnaces, which are largely impregnated with sulphurous acid, are very destructive to wires, and a No. 8 wire will last only about three years. A piece of line wire shown, which two years ago was either a No. 12 or 14, had been reduced to nearly a 20 when taken down.

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THE ELECTRIC LIGHTING ACT, 1882.

A meeting of the general committee formed to frame amendments of the Electric Lighting Act, 1882, for the consideration of the Board of Trade, was held at the offices of the Anglo-American Brush Electric Light Corporation, Belvedere-road, S.E., on Wednesday, the 11th inst., the Right Hon. Lord Thurlow, chairman of the committee, presiding The report of the executive committee, and a draft Bill amending the Electric Lighting Act, 1882, on the basis of the Gas Acts, were submitted, and the details of the same having been explained, it was resolved unanimously, on the motion of Viscount Anson, that the report of the executive and the draft Bill be received and approved.

The Chairman was then asked to communicate with the President of the Board of Trade with the view to a deputation of the committee attending at the Board ol Trade to learn his views on the proposal of the committee.

The executive having been unanimously re-elected, the proceedings terminated with a vote of thanks to the chairman.

Report of the executive committee, appointed on the 17th day of December, 1884, by the General Committee formed on the suggestion of the President of the Board of Trade, to frame clauses in amendment of the Electric Lighting Act, 1882, and to confer with the Board of Trade as to the terms of the provisional orders and licences.

The executive committee have, after deliberate and careful consideration, arrived unanimously at the conclusion that the electric light companies should demand to be put simply in the same position as the gas companies are, both as regards their privileges and their obligations. The reasons which have led them to adopt this conclusion are—*in the first place*, that they believe no satisfactory solution of the question of general electric lighting can be arrived at by amending the Act on the basis of a modified purchase option clause, the existence of such an option in any form rendering it impossible to attract from time to time fresh capital to the enterprise, or indeed to attract any capital at all; and, *in the second place*, that the conclusion itself is clear and intelligible, and will at once commend itself to the public by its fairness and simplicity.

The executive have decided, after a careful examination of the general Acts and the principal special Acts relating to the gas companies, that the electric light companies may safely undertake the business of general lighting under conditions entirely similar to those of the gas undertakings; and to carry out their recommendation they have prepared the draft of a Bill, which they now submit to the general committee, together with a brief memorandum of objects. The executive have further drawn up the following statement, which they also submit to the general committee, containing in some detail the principal reasons in support of their conclusion, which they think will commend themselves to the public, and which they trust will receive favourable consideration from the Board of Trade.

Reasons.

There are few things in the history of industrial undertakings more striking than the degree in which America has outstripped England in electric lighting. To say that the progress there has been tenfold that in England would be short of the truth.

In a recent lecture by Mr. Preece, F.R.S., who had just returned from America, he mentions that the number of arc lamps in the States is 90,000. In New York there is a central station with over 12,000 incandescent lamps, where the current has been maintained for two years with only two and a-half hours' stoppage. Two larger stations in the upper part of New York are now being set up and will shortly be open. Even small provincial towns in the States have their arc lamps, and there is a village in New Jersey with 1,200 incandescent lamps.

In this country electricity has been a thoroughly practical success in ship lighting, where the industry is untrammelled by authority and conducted on the footing of an ordinary commercial business. In its application to ships, and particularly to those of H.M. navy and the large ocean-going steamers, the electric light is rapidly displacing the use of oil. Manufacturers in this country have also succeeded in creating a consider able demand for their goods for foreign countries and the colonies. Had it not been for such openings their manufacturing plant would have been comparatlvely idle.

Electric lighting in England has succeeded in isolated installations; but house-to-house lighting on a large scale is hampered by the difficulty that it requires a wayleave under the streets, with some power of temporarily disturbing the surface. The Electric Lighting Act, 1882, has laid down the general conditions under which such wayleaves may be obtained, and by implication prohibits the local authorities from granting a wayleave on any other terms. The conditions are most unfair in their character; but so strong was the belief in the success of electric lighting that, after keen competition and many months of hard work, at a cost of many thousands of pounds, several provisional orders under the terms of this Act have been obtained by companies and individuals. Those who succeeded in securing the orders believed that they had thereby obtained valuable concessions; but, on applying the test of negotiating for capital to work the orders, or considering whether they were justified in spending shareholders' money for this purpose, they found that neither would they be justified in calling upon their shareholders for the necessary capital nor could they induce capitalists to provide fresh money for central station lighting on the present conditions.

The result is that not a single central station under these orders is working, or is in course of establishment in London or in any of the large cities in the United Kingdom.

This circumstance has given rise to grave complaints against the Act, not only in England, but also in America. The following is an extract of a letter recently received from the president of the Edison Electric Light Company of New York:—"The almost total collapse of electric lighting in England, together with the assurance which I receive from time to time to the effect that until Parliament reverses its former action, or till it amends the Electric Lighting Bill, no development of central station business can be expected in England, has given us on this side of the Atlantic much serious concern. From the many discussions I have had with scientific English friends visiting this country during the past summer, I have been led to believe that central station, or house-to-house lighting, is deferred into the dim distance of the future by virtue of Mr. Chamberlain's Bill for the *promotion* of electric lighting, and it is hopeless to do anything in this matter till someone introduces and passes a Bill for the *prevention* of the industry."

The principle upon which this Electric Lighting Act, 1882, proceeds is that general electric lighting may be undertaken by local authorities, or by companies, or by private persons; but that if the local authorities, whether because they regard the business as too risky, or from any other cause, decline the venture, and the work is undertaken by companies, the local authority which has refused to avail itself of its chance of undertaking the work at the outset, shall be able after a comparatively short period to acquire upon terms, which it would be a misuse of ordinary language to call purchase, all the property of the undertakers.

General electric lighting requires a large enpenditure of capital; the risks are known to be great, and capitalists must be treated with ordinary fairness to induce them to put money into such an undertaking.

Under the Act, while the earning of a dividend is problematical, it seems that under any circumstances much of the capital must be lost; for if the undertaking fails, this of necessity involves the loss of a great portion of the capital, and if their enterprise is successful the undertakers, instead of being compensated for the risk they have run, will lose a large portion of their capital and be deprived of the management under which that success had been achieved. Moreover, the dread of this unfair and unprecedented purchase option clause will hang over the enterprise and will be the means of arresting its natural growth and development, as it will prevent the application of fresh capital, which would be from time to time required as the system grows in popularity and is improved in economy.

But not only has the purchase option clause deterred capital from the enterprise, it has also furnished the local authorities with a distinct motive for declining the risk of embarking on electric lighting. It is the obvious policy of local authorities, having the option to purchase an undertaking on which they incur no liability, to wait until the risk is undertaken by others, so that they may be in a position to acquire the property only if and when the enterprise has proved successful.

The executive committee are unable to devise any terms of option which shall avoid the double consequence of deterring capital and encouraging local authorities in the policy of abstention.

We have not omitted to observe the hint thrown out by Mr. Chamberlain, that while the community should be enabled to resume this "monopoly" after twenty-one years, it should do so on terms which would at all events fairly recoup the undertakers for all legitimate outlay. If we were to formulate the terms which we should consider necessary *fairly* to recoup the undertakers for all legitimate outlay, including (as we should understand was fair) *compensation for risk*, we should only demonstrate the impossibility of framing a fair purchase option clause which would be workable. If really fair compensation for risk were included in the terms, it would only be in exceptionable cases of success that the option would be of any use. In the majority of cases the option would be illusory, and the clause a dead letter; and if in the exceptional case, where great success has been obtained by good management, the managers are liable to be displaced by the local authority, who may choose to exercise the option to buy them out—though at a high price—we think the condition will be mischievous in its tendency to paralyse the undertaking.

If, on the other hand, it is not meant to include compensation for risk in the terms of purchase, and it is proposed that the unsuccessful undertakings shall bear the loss, while the successful ones are to be bought out on terms which will recoup the undertakers merely in cost price and interest, it is needless to point out that capital cannot be obtained on these terms; the terms would still have the double effect of deterring capital and encouraging local authorities to abstain from the venture at the outset.

The purchase option clause was an experiment, and it has failed. It is absolutely without precedent.

We observe that Mr. Chamberlain said, in answer to the deputation which resulted in the formation of the committee, that there were precisely the same restrictions in the case of tramways to those in the Electric Lighting Act.

That is certainly not the case. To say nothing of the circumstance that in the case of tramways the price is left to arbitration without the prohibition against taking into account *goodwill* (or present profits), the tramway companies will be left in possession of their rolling stock and movable property; and, besides, the Tramways Act contains a very important clause disabling the local authority under any circumstances from working the undertaking. What they acquire by the purchase is the bare property, subject to the virtual obligation to lease the undertaking to some person or body of persons capable of working it. The competition is not likely to be serious. The old company will be in readiness with their rolling stock, movable property, and experience, and will doubtless obtain the lease at a rent representing fair interest for the outlay made by the local authority. It is indeed morally certain that in the case of a tramway, the purchase option clause, if exercised, will make little difference in the situation. The tramway company will retain the management, and probably make little or no sacrifice of annual income.

The conditions of the Electric Lighting Act, 1882, differ fundamentally. If their undertaking has been a disastrous failure, *cadit quæstio*, they bear

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the loss ; but if it is struggling towards success (the utmost that can be hoped for in twenty-one years' time) the local authority may take the property and assume the management at a price which, if the option is not to be illusory, will be necessarily unfair.

But we further contend that there is no real analogy between the cases of tramways and electric lighting undertakings. There were no intricate scientific questions involved in laying tramways, and it was not difficult to calculate approximately the capital outlay and the cost of working, tramways having been used in other countries before they were introduced here. Moreover, the use made by tramways of the streets and roadways is a very different thing from the use proposed to be made by the electric lighting undertakers. The tramways have a use of many miles of the public roadways which continually and seriously interferes with the ordinary public user of the street, causing much inconvenience and even risk.

Another argument which has been used (though not by Mr. Chamberlain) is that the water companies are now practically masters of the situation, in the supply of one of the first necessities of life, and can only be bought at a very high price. It is not for us to argue the case for the water companies, but it may be pointed out that for many years the profits of the shareholders were by no means excessive. It is also to be remembered that the powers required by the water companies, extending as they do to the absorption of large natural resources, are very different in kind from the simple wayleave and power of temporary disturbance asked by the electric lighting companies.

As to the purchase of the telegraphs by the Government it has been said that the terms were exorbitant. Under the Telegraph Act, 1868, the Postmaster-General was empowered, with the consent of the Treasury, to purchase the telegraphs on the usual terms of expropriation), that is to say (failing agreement) by arbitration. The interests of the telegraph companies were in fact purchased by agreement, but in the case of some (at least) of the railway companies, arbitration was resorted to. The suggestion really resolves itself into a grumble against the awards. It affords no reason why electric lighting undertakers should submit, by anticipation, to be expropriated on unfair terms, and without compensation for risks which are at present incapable of estimation. After all, it does not appear that the purchase of telegraphs has been otherwise than a good commercial bargain for the Government. It is instructive to know that with this fully before them, the Treasury sanctioned the arrangement which has been made between the Postmaster-General and the telephone companies for the compulsory purchase of their undertaking, and which provides that at certain fixed dates the Postmaster-General may give notice to purchase the various exchanges, and the agreement simply provides that the price to be paid shall in case of difference be determined by arbitration under the Common Law Procedure Act. This bargain, it may be remarked in passing, was made after (and notwithstanding) the Post Office had established by legal decision (founded on the terms of the Telegraph Act, 1869) an exclusive privilege against the telephone companies.

It may here be not irrelevant to advert to the option reserved by the Indian Government to purchase the railways. In the case of the Indian railways, the Government *undertook the risk* from the outset, by guaranteeing a permanent 5 per cent. dividend, and the option of purchase was reserved upon average market value, which was itself enhanced and sustained by the guarantee. The case therefore affords no parallel in favour of the option of purchase applied to electric lighting undertakings ; but it is remarkable to find that when the option came to be actually exercised, in the case of the earliest and one of the most successful of these undertakings, the East Indian Railway, so much importance was attached to the object of keeping the management in the hands of those who had formed and developed the enterprise, that special arrangements were made, confirmed by Act of the Imperial Parliament, for the purpose of continuing the management and giving the shareholders the option of retaining an interest in the continued success of the undertaking.

The undertakings which really bear a fair analogy to electric lighting undertakings are those of their rivals, the gas companies. It seems necessary to recall a few of the leading facts in the history of this industry.

Take the case of the Gas Light and Coke Company. This company was formed in 1809, about 16 years after it had been practically demonstrated that a house could be safely lighted by gas. By an Act passed in 1810 the Crown was authorised to grant them a charter giving them privileges for a term of 21 years. This charter was granted on the 30th of April, 1812. To quote from one of their recent reports : "For years the rental was little more than nominal, and when at a later period it had succeeded in forcing itself into a position of some public utility and realising a fitful profit, the shares were almost always at a heavy discount. The dividend, when any was paid, seldom exceeded 6 per cent. The company's manufacture was in its early stage naturally crude and imperfect ; the yield of gas from each ton of coal was very small, and for many years the price remained at about 15s. per 1,000 cubic feet." But in the year 1816 their charter was extended for a further period of thirty years, and in the year 1819 they were incorporated with perpetual rights, and at a subsequent date their dividends were regulated in the manner which has since become univeral. It does not appear that the dividends were regulated at all in the earlier periods of the gas companies, in fact not until the year 1823, that is thirty years after the introduction of gas lighting in a house.

The first gas company formed out of London was at Preston, in Lancashire, in 1816. It commenced with a capital of £2,000 ; in 1817 the capital was £11,000 ; and in 1839, when the company was incorporated, the capital was raised to £30,000. Situated within a few miles of the cannel coal-pits, and with exceptionally favourable local circumstances, they paid a dividend at the rate of 5 per cent. in 1817, none for the years 1818, 1819, and 1820 ; but in 1821 the dividend reached 6 per cent., which was the rate until 1825. It is clear that if the conditions of the Electric Lighting Act had been applied to gas in its infancy, this important and useful industry would have died a natural death in the early part of this century.

The difficulties which gas had in its early times to overcome are greatly enhanced in the case of electric lighting by the circumstance that gas already occupies the field with its enormous fixed plant and invested capital. The position in which the electric lighting companies are placed in this competition is well expressed in the able and important report of the committee of the society called the *Dynamicables*. "Under the existing state of things the legislative conditions are incomparably more favourable to gas than to the electric light, and must enable it to undersell its rival in any competition there may be between them. The gas companies hold their powers in perpetuity, and they can afford a present loss or content themselves with diminished profits for a time in order to get rid of a troublesome competitor, the more so as they are entitled to make up any deficiency in the statutory dividends by increased dividends in future years ; and the profitable nature of gas production would certainly enable them to do so."

It is sufficiently arduous for electric lighting to contend with gas upon conditions similar to those under which gas undertakings are now placed; but these conditions are at least the result of a compromise shown by experience to be possible, between the encouragement of enterprise and the security of the public against an undue use of monopoly.

The existing gas legislation does in effect secure to the community the benefit of whatever profit is earned exceeding what is contemplated by the terms of the Act as a fair remunerative profit upon the original capital embarked in the enterprise. As to new capital, the auction clauses secure that it shall be raised at the minimum market rate ; and any profit above that rate earned on such new capital goes to diminish the price, for the benefit of the consumer within the area.

The auction clauses in the Gas Acts have been well devised for the precise object which the purchase option clause in the Electric Lighting Act was apparently intended to secure. Their operation is self-adjusting, according to the state of progress in the industry. They have succeeded in their object, so that without acting as a deterrent to investors they effectually impose a limit upon profits and give substantial benefit to the consumer.

Moreover the sliding scale applied to gas companies, and by the amended Bill proposed to be applied to electric lighting companies, has restored to the gas companies that incentive to exertion which the hard and fast limit of a maximum dividend had taken away, with the result that such improvements are effected in the manufacture and distribution as to enable the companies to reduce their price, so that at the present time 16-candle gas is sold in London for as little as three shillings per thousand feet, a condition of things there can be no hesitation in saying that would not have been reached had the management been in the hands of public bodies not stimulated to improvement by the hope of pecuniary reward.

The purchase option clause has conspicuously failed, and the executive committee have deliberately formed the conclusion that such failure cannot be remedied by any modification in the terms of the option. We believe that a purchase option clause without a corresponding guarantee, as in the case of the Indian railway contracts, must necessarily fail, inasmuch as without the steady market value which could only be secured by a guarantee, the terms of option, if not illusory, must be deterrent to an extent out of all proportion to the benefit which can possibly accrue to the community.

It can hardly be necessary to argue the general question that in order to develop a nascent industry, and more especially to force it on the public in the face of a rival manufacture already established with a large fixed capital, it is necessary to have all the encouragement which, consistently with the interest of the public, can be safely given to it.

It may, however, be well on this point to remind the committee of the specific evidence which has been given by a great authority upon a parallel question. In the evidence taken before the late Patent Commission, the question had been mooted as to the public utility of the monopoly given by the Patent Laws, Sir Wm. Armstrong having contended that these monopolies have acted as a restraint upon the development of manufactures. The result of the whole evidence was an overwhelming concurrence of opinion as to the utility of patents in assisting the progress of industry by enabling new and important manufactures to become developed in the face of established rivals. The specific evidence referred to is that of Sir Henry (then Mr.) Bessemer. It was to the effect that his own invention—which it is needless to say has been one of the most beneficial and far-reaching advances ever made in industrial progress—would have fallen to the ground had it not been for the inducement held out by Patent Law to expend money in developing his process and forcing it on the trade. In fact, he spent more than £20,000 in developing and perfecting the invention before he could effectually bring his manufactured steel into the market. But for the patent law he could not have found the means of improving the invention so as to be worked commercially. It seems impossible to doubt that if the Bessemer process had been hampered with the condition that any manufacturer wishing to use it had to apply to Parliament for powers, which could only be obtained on terms of putting a fixed period upon his enterprise, the industry would have failed to establish itself, and the enormous economies and improvements effected by it would have been lost.

In the comparison between electric lighting and gas, the one advantage commonly claimed for gas is that of economy. The apparent economy of gas, however, is based on the assumption that the oxygen consumed by the burning of the gas costs nothing. It is estimated that every gas burner consumes as much oxygen as a living person. The large use of gas, even supposing it to be of extreme purity, is therefore necessarily one of the degenerating influences of our crowded cities. It is also to be considered that, owing to the consumption of coal for electric lighting being less than that required for producing an equal amount of light by gas, the resources of this country will, in the event of electric lighting being

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established on a large scale, be economised and prolonged, an economy which will be materially aided by the circumstance that in many localities water power will be available for electric lighting.

It will no doubt in any case be a long time before electric lighting can exercise a sensible influence in displacing gas. With a fair field of competition, but not without it, this is ultimately possible. A serious competition will in the meantime greatly improve the quality of gas supply, as, indeed, the threat of competition a short time ago did to a very sensible extent.

The executive committee suggest, as another reason for preferring a limit upon the profits of undertakers to a fixed period upon their existence, that limited dividends are more likely to attract steady and genuine investment, but will tend to discourage speculation on exaggerated and unreal expectations. It is indeed possible that on the basis of a fixed period, and unlimited profits in the meantime, a few speculative undertakings may be launched, with the result of disappointment to extravagant expectations, and of rendering it impossible at the critical time to attract fresh capital to the necessary extension of the enterprise.

It is to be remembered that as electric lighting develops and advances in popular estimation, a large and increasing capital will be necessary to extend the system, and make the supply still cheaper and more popular. This will be the critical period, and the ultimate success of electric lighting may not be attained until a large portion of the term of the purchase option clause has expired. It is impossible that the new capital can in the remainder of the term earn a fair commercial profit, as well as the means of providing a sinking fund for replacing the loss. The price loaded with the cost of providing a sinking fund would be prohibitive to extended consumption. Any proposed extension of the enterprise at such a time must necessarily be a failure commercially. The undertakers would be unable to obtain fresh capital in the market, and if there remained any uncalled capital already subscribed, the calls could only be made by a cruel injustice to the shareholders.

If electric lighting undertakings are put on a footing of equality with gas, central station lighting will at least be tried on a scale sufficient to make the competition with gas serious.

The executive committee believe that such undertakings will, through difficulties, achieve ultimate success.

The possibility of electric lighting as a large and popular industry now hangs in the balance, and if the committee should adopt our recommendation to demand that the electric lighting industry shall be put on the same footing as gas, we think it fair that the argument should be respectfully urged on the Board of Trade, that if this reasonable demand is not conceded, upon them will rest the responsibility for the failure of electric lighting in this country, and for the far-reaching consequences which may follow such failure. How far these consequences may extend we cannot presume to speculate. Even at the present moment we believe that the stimulus given to genuine enterprise in electric lighting by putting it on the gas footing would be considerable. If that enterprise succeeds, a further stimulus will be given to the application of science to industry which cannot but be important. Indeed, the encouragement of electric lighting at the present moment might be the turning point in the long-continued depression of trade under which the country has lately been suffering. Having regard to the keenness of competition which has now overtaken the long undisputed lead of this country in industrial progress—having regard to the circumstance that England is already distanced by America in the industry of electric lighting—that this may be a step towards leaving to America a permanent lead in the new applications of science—and that America still holds in reserve the resources of the approaching extinction of her debt and the ultimate adoption of free trade—we think the Board of Trade will attach due weight to the importance of giving at this critical stage a fair field to the development of electric lighting enterprise.

With these larger considerations the committee are not primarily concerned. As representing the interests vitally affected the question for the committee is on what terms we can call for or invite capital to the enterprise of public electric lighting. We must keep in view that the electric lighting industry will in any case remain in possession of the smaller and safer field, which may be exploited on conditions not involving wayleaves through the streets. The electric light companies will continue in possession of the ship-lighting industry, and on land they will be able to conduct electric lighting on a small scale as an expensive luxury for those who are able to pay for it. As to the larger field, if the industry can be worked only on the terms that property which is the result of private money and enterprise of the undertakers—not consisting of an undertaking built upon land the subject of a concession, but as much their own as the property of an insurance company or telegraph construction company which has been obliged to apply to Parliament for powers affecting its constitution—is to be taken from them by the local authority without either a fair bargain or an Act of Expropriation by the Legislature of the day, we, as representing those whose capital is proposed to be at risk, feel bound to pronounce the words *non possumus*. We cannot, we dare not, we will not embark our capital on these terms.

We may point out, however, that the local authorities, without an unfair acquisition of the property of the undertaking, will have, in any case, a large share in its future success. Apart from the considerations of refinement and health to the ratepayers, they will enjoy the substantial advantage of the creation of a considerable rateable property.

Moreover, while unable to accept any purchase option clause, we think it quite right that all reasonable facilities should be given to local authorities to acquire electric lighting undertakings by agreement. A provision of that kind has already been embodied in the Public Health Act with regard to gas, and we have accordingly inserted in our draft Bill a similar provision with regard to electric lighting undertakings. Such a provision will, we think, give local authorities who have declined the risk at the outset, a certain *locus pœnitentiæ* if they are wise in time by offering liberal terms to the undertakers when ultimate success is fairly assured. It is not improbable that at such a time the undertakers may be open to a fair bargain so as to have the opportunity of transferring their capital for the development of electric lighting enterprise in a new field.

THURLOW, Chairman.

London, March, 1885.

ON THE CHARACTERISTIC CURVES AND SURFACES OF INCANDESCENT LAMPS.*

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Recent issues of a scientific journal† have contained some interesting letters and notes on the life of incandescent lamps, and on resulting deductions to be made therefrom. The difficulty of the full and complete discussion of this subject is the absence of sufficiently prolonged experiments to give statistics reliable for this purpose. These can only be obtained at great expense and by experiments lasting over a considerable time, but the results to hand make a preliminary investigation interesting on the connection which exists between the life of incandescent lamps and the other correlated quantities.

The manufacture of incandescent lamps has now advanced to such a condition that the accidents of manufacture are greatly under control. The conditions necessary to get a good lamp are fairly well understood, and the physical actions going on in the lamps are also to a great extent known. We now know that the expectations of earlier investigation of getting an absolutely unalterable carbon incandescent lamp are not destined to be fulfilled, but we know that the gradual destruction of the filament is an operation dependent upon several causes, which may be greatly delayed by attention to, and success in certain operations of manufacture.

The gradual destruction of the carbon filament in a vacuum lamp is a kind of erosion taking place at one or more points. Observation seems to show that in a single loop filament this cutting through takes place most generally near the negative side. The determining cause of breakage is, however, temperature, and carbon filaments which present such inequalities of resistance as to give rise to spots of higher temperature might, other things being equal, be expected to be doomed to a short career. Lamp filaments are therefore like human lives ; some come into the world with a taint of disease upon them, in the shape of irregularity of structure, which predisposes to an early death ; but, nevertheless, as even in the case of suicide, the great law of averages overrides particular instances, and gives us, in the case of a sufficiently extended series of observations, a law connecting the average behaviour under fixed circumstances.

Experience gained during three years of commercial manufacture and use of incandescent lamps has demonstrated that when a large number of filaments are prepared with identical care, and the lamps made with them sorted out into batches, and worked with varying electromotive force, that there is a very constant relation between the average efficiency or candles per horse-power and the average duration or life, and the working potential or volts of the lamp. Now, in a general way we do not know what the form of the function is that connects these three quantities, or any two of them, but there have been a large number of observations on the relation of certain variables which indicate as a most probable form an exponential function.

There are four variables between which a relation is required—electromotive force, resistance, candle-power, and life. The third of these is at present somewhat vague and indeterminate. What we really are concerned with is the total eye affecting radiation, and our present methods only allow of a certain more or less imperfect comparison of this as a whole with that of a standard candle, or a calculation of the integral deduced from observation of the relative intensities of certain rays. Accordingly, of these four quantities two alone can be measured with any great accuracy. One is merely an average, and the other is necessarily a somewhat ill-defined quantity.

Between any two of these variables we can seek a relation, and having a number of observations we plot down these in what are best called the characteristic curves of the lamp. Now two of the most important of these curves are those connecting the electromotive force and efficiency, or candles per horse-power, and the electromotive force and life, and they may therefore be called the principal characteristic curves of the lamp. Three other useful curves may be obtained by plotting down the curves connecting candle-power and current, candle-power and electromotive force, and electromotive force and resistance. These may be called subsidiary characteristic curves.

Since the life and efficiency of a lamp vary together with the electromotive force, we can only properly represent the relation between the three by a *surface*, which may be called the characteristic surface of the lamp.

Take three rectangular axes, x, y, z (see Fig. 1), and let distances measured outwards represent life, candles per horse-power and electromotive force. Let a curve be drawn on the $y\,x$ plane, representing the relation of electromotive force and life, and one on the $x\,z$ plane, representing electromotive force and efficiency ; let the ordinates be drawn at various points to both the curves, starting from abscissæ, representing certain pressures v_1 v_2, &c. ; complete the rectangle on the ordinates k, l, &c., and we see that these rectangles form the orthogonal sections of a solid bounded respectively by the two planes $x\,y$ and $x\,z$ and two curved

* Read at the Physical Society, 14th March, 1885.

† *The Electrician*, Vol. XIV., 1885, pp. 246, 294, 311, 347.

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surfaces, of which the characteristic curves l and k are the traces on these planes. The surface of this volume may be called the characteristic surface of the lamp. We see that the area of the orthogonal section parallel to $y\,z$ gradually increases to a maximum, and then decreases. This is obviously because for zero electromotive force life is infinite and candles per horse-power zero ; whilst for very high electromotive force life is zero, and candles per horse-power, or efficiency, a maximum. Now the area of cross section, which is a maximum for a certain value, v_2, of electromotive force, represents the product of life and candles per horse-power, or the maximum candle hours per horse-power it is possible to get, and the value of $k\,l$ is therefore a very important quantity. I shall call this maximum value of $k\,l$ the principal modulus of the lamp, because the value of the lamp for commercial purposes is obtained by dividing the numerical representing the principal modulus by the price of the lamp, taking either the cost of manufacture or the selling price according as the question is considered from a manufacturer's or purchaser's point of view.

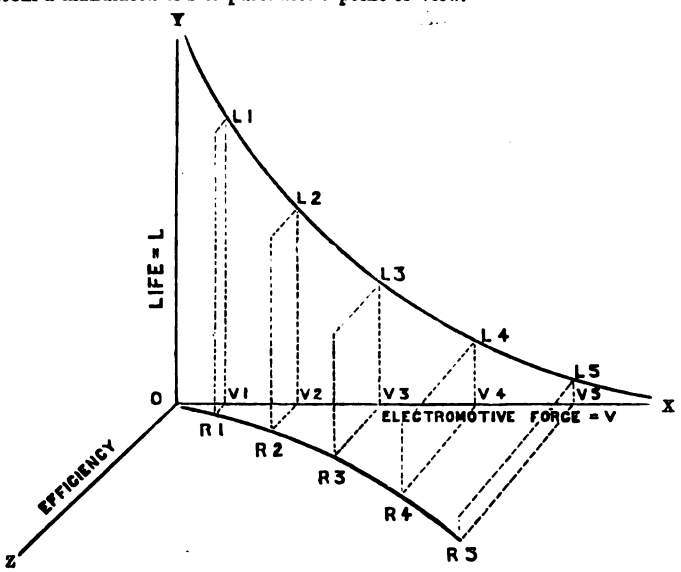

FIG. 1.—Diagram of the principal characteristic curves of a lamp. Efficiency = R.

The product $k\,l$ is itself a function of the electromotive force, and the value of the electromotive force which makes this quantity a maximumis an important one to determine. It is the pressure at which the lamp should be worked in order to realise the greatest quantity of light for a given expenditure of energy in the lamp.

TABLE I.

Volts.	Life.	$\log_{10}$ (volts).	$\log_{10}$ (life).
95	3595	1·97772	3·55570
96	2751	1·98227	3·43949
97	2135	1·98677	3·32940
98	1645	1·99123	3·21617
99	1277	1·99564	3·10619
100	1000	2·00000	3·00000
101	785	2·00432	2·89487
102	601	2·00860	2·77887
103	477	2·01284	2·67852
104	375	2·01703	2·57403
105	284	2·02119	2·45332

Let us next consider the form of the function which expresses these characteristic curves. Take, for instance, the curve of life and electromotive force. We do not know whether this curve is a continuous curve, whether it is assymptotic to axis of y, or, in fact, how it behaves beyond the limits of the values of electromotive force v, for which lamps are incandescent. We have, however, certain values for l corresponding to values of v, not lying far on either side of the ordinary so-called "marked volts" of the lamp. When the writer was in America he was shown a large number of observations made with the view of determining the relation between average life and electromotive force, not far on either side of 100 volts taken for the Edison 108 volt A lamp. For this lamp the life pressure curve at or near the working pressure is approximately a logarithmic curve, whose equation is

$$l = A v^{-a}$$

when A and a are constants, and for the Edison 16-candle 105 volt lamp a is nearly twenty-five ; and accordingly life varies inversely as the twenty-fifth power, roughly, of the electromotive force. In the figures shown to the writer the life-pressure curve had been drawn for pressures corresponding to lives far in excess of what could actually have been observed during the time filament lamps have been made, reaching up to 11,793 hours. This is obviously improper. We do not know that a is not itself a function of v, and for pressures departing far from the ordinary working pressure, the variation of average life and pressure is not probably expressed by so simple a relation, and we cannot go fairly beyond the limits of actually observed lives M. Foussat has recently communicated to a scientific journal the results of observations on the life of French Edison lamps.

Now, the figures given by M. G Foussat, on p. 246 of *The Electrician* for 1885, stated to be the result of a large number of observations on the relation of average life and pressure, at or near 100 volts, conform approximately to the above law. Taking M. Foussat's numbers for life and electromotive force, and taking logarithms of both we have the figures given in Table I. (in preceding column).

Writing down the differences between successive values of $\log v$ and $\log l$ we get the numbers :—

455 11621	432 10513
450 11009	428 11600
446 11323	424 10035
441 10998	419 10449
436 10619	416 12071

Now, if $l = A\,v^{-a}$ $\log l - \log l_1 = -a(\log A\,v - \log A\,v_1)$, where l and l_1 v and v_1 are adjacent values of l and v, accordingly

$$a = -\frac{\log l - \log l_1}{\log A\,v - \log A\,v_1}.$$

The mean of the differences of $\log l$ divided by the mean of the differences of $\log v$ gives 25·4 nearly, and accordingly M. Foussat's numbers agree with those found in America in assinging to a a value not far from twenty-five for the Edison lamp. In the neighbourhood of 100 volts

$$l = A\,v^{-25}$$

or average life varies inversely as the twenty-fifth power of electromotive force.

This, however, is easily seen to be a very rough approximation. The successive quotients of life difference by volt difference are not constant, and the above simple exponential formula can not be admitted as anything more than a very imperfect connection. In examining the Carlisle tables of mortality which give the expectation of life at every age drawn from a very large number of observations, it was apparent that an empirical formula, connecting the two quantities could be obtained of a form

$$\log e = a + b\,x + c\,x^2 + \&c.,^*$$

when e = expectation of life at any age x. I was led therefore to try if such an empirical formula better suited the present case, and a process of trial and failure showed that

$$10 \log l = 135 - v - \frac{v^2}{2{,}000}$$

is a formula which gives very nearly correct results in calculating the life of a lamp, l, given the working pressure v in volts. This may be expressed otherwise :—

$$\log l = 13{\cdot}5 - \frac{v}{10} - \frac{v^2}{20{,}000},$$

or

$$l = 10^{13{\cdot}5 - {\cdot}1v - {\cdot}00005\,v^2}.$$

Calculating by this formula, we get the following values for $\log l$ and l, l being the average life in hours of the 100 volt Edison lamp as made in France :—

Calculated by formula.		Observed.	
l	$\log l$	$\log l$	l
3539	3·5488	3·5557	3595
2749	3·4392	3·4395	2751
2136	3·3296	3·3294	2135
1658	3·2196	3·2167	1645
1289	3·1100	3·1062	1277
1000	3·0000	3·0000	1000
776	2·8900	2·8948	785
602	2·7798	2·7788	601
467	2·6698	2·6785	477
362	2·5592	2·5740	375
281	2·4488	2·4533	284

It is evident, then, that the simple exponential function does not give nearly as good results as a formula of this latter description, and there is no doubt but that by a suitable selection of constants, a formula can be obtained expressing the life of the lamp as a function of electromotive force throughout an observed range, which shall be closely in accordance with observed facts.† Until, however, a much larger collection of statistics

* Let x be the age, and e the expectation of life at that age. Then, by the Carlisle tables of mortality, at the several ages—10, 20, 30, 40, 50, 60, 70, 80, 90, the corresponding expectations of life are—48·82, 41·46, 34·34, 27·61, 21·11, 14·34, 9·18, 5·51, 3·28 ; and it can easily be found that $10 \log e = 17{\cdot}2 - \frac{x}{100} - \frac{14}{10{,}000}\,x^2$ very nearly, the calculated values from which are—49·6, 44, 36·6, 28·6, 20·9, 14·3, 9·64, 5·54, 3·14.

† Mr. F. M. Wright has given, in *The Electrician*, p. 311, 1885, a formula,

$$100 - V = 9{\cdot}098213 \log \frac{L}{1000}$$

This is equivalent to

$$9{\cdot}09 \log L = 127 - V$$

and Professors Ayrton and Perry have given

$$L = 10^{14 - {\cdot}11v}$$

or

$$10 \log L = 140 - 1{\cdot}1v$$

both of which are nearly equivalent to the formula given in the text.

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is obtained we shall not be in any position to determine if these constants are definite for each type of lamp or kind of carbon, and whether the average life of a lamp can be predicted from a knowledge of these constants.

(TO BE CONTINUED.)

PHYSICAL SOCIETY.—March 14.

Professor Guthrie, President, in the chair.

Captain ABNY read a paper upon "Recent Researches on Radiation." In general a hot body loses heat in three ways—by conduction, by convection, and by radiation. In the case of the carbon filament of an incandescent lamp the loss of heat by conduction is insignificant, and a series of experiments has been made to determine the amount of radiation, that is the energy expended as radiant heat for every unit of electrical energy expended in the lamp. Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that at pressures between 40 millionths and one millionth of an atmosphere the radiation varies as the mean molecular free path. On the author's experiments incandescent lamps of thin glass fibre exhausted to different degrees, the radiation being measured by a thermopile, it was found that at from 40 millionths to 10 millionths of an atmosphere the radiation increases uniformly with decrease of pressure, but that beyond this point it becomes nearly constant. A more important question is to determine the amount of radiation for any particular ray under the above conditions. This was effected by placing a small thermopile in the different parts of the spectrum. Plotting the results with watts as abscissæ, and radiation as ordinates, the curves for each kind of ray are found to be very accurately hyperbolas with vertical axes. This result gives a method for rendering identical the quality of the light emitted by two lamps. We have only to find the radiation corresponding to a particular kind of light for one lamp, and then by examining the curve corresponding to that ray for the other lamp, find for what number of watts the radiation is the same.

Professor J. A. FLEMING read a paper on "Characteristic Curves of Incandescent Lamps," which we shall give elsewhere.

Mr. C. CLEMINSHAW described some "Further Experiments in Spectrum Analysis." These consisted of methods of obtaining the inversion of the sodium line in the spectrum of the limelight. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon, in which sodium is ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the immersion of the D line.

Professor GUTHRIE, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.

An abstract of a communication by Dr. John Hopkinson on "Sir W. Thomson's Quadrant Electrometer" was read by the secretary. According to Maxwell the depression produced by a given difference of potential between the quadrants is given by the formula

$$d=\lambda\,(A-B)\left(C-\frac{A+B}{2}\right)$$

where A and B are the potentials of the quadrants, and C that of the needle. Dr. Hopkinson finds, however, that the constant λ should be $\frac{\lambda}{1+kC^2}$, the quantity k being due to and depending on the unsymmetrical position of the needle with respect to the quadrants.

COMPANIES' MEETINGS & REPORTS.

South Eastern (Brush) Electric Light and Power Company (Limited).

In compliance with a requisition made by certain shareholders of the Company, an extraordinary general meeting was held on the 13th inst., at the offices, 68A, Cow Cross-street, E.C., for considering the following resolutions proposed by such requisition :—(1) That the Company be wound up voluntarily. (2) That Charles Hay Stewart, of Leadenhall-chambers, St. Mary-axe, London, and Alexander Leith Riddell, of 27, Austin Friars, London, be appointed voluntary liquidators of the said Company.

The SECRETARY (Mr. George Offor, jun.), having read the notice convening the meeting, as above,

The CHAIRMAN said: Gentlemen, we have reached to-day a very important crisis in the affairs of this Company, and it is for you to say whether it should be put an end to suddenly and, as I think, ignominiously, or whether you will allow time for it to go out of existence with something like credit and dignity. I do not suppose that I shall influence the vote of anyone who has come here with his mind made up. Those who are bent on self-destruction seldom, I believe, listen to reason; but I have this to say for the benefit of those who are not present—that the position in which we find ourselves now—and that condition of things which has been brought about by those who are opposing the Board—has left the Company a very poor chance of realising the assets we possess. Those who have taken upon themselves to advise the shareholders have announced publicly that the chance of making any terms that would be beneficial to the Company is beyond reasonable expectation, and we have also heard from the same quarter that the chance of selling the Colchester installation is—because it does not happen to pay at the moment—a thing we cannot expect. Now, we think otherwise. With regard to that Colchester installation, whatever may be thought of it, we say we have proved to demonstration the success of our system. All that is wanted is the more extended application of that system to make it a commercial success. With regard to the approach which we are about to make to the Brush Company, though we were told at our last meeting by one who I think should have known better—by a director of that company—that he was authorised to say that they would have nothing to do with us—[A Voice: Quite right.]—well, perhaps by this time Mr. Joseph Braithwaite has found out that when he speaks of his being authorised to act for his company that that is not the case. We have now a communication from the Brush Company, and are to wait upon them next Wednesday, at the invitation of the Board of that company, to consider what terms can be made with them. In addition to that, we have been approached by those who are anxious to take over our work at Colchester. Whether anything will come of that I cannot say; but those who are interested in electric light companies do not desire—and I think they should not—that this Company should be wiped out of existence in the way proposed. There is an aspect of the question which I think is very important—that is, how will our proceedings affect the interests of other electric light companies, and how will they affect the public? I take it that all electric light companies are at the present moment on their trial, and whatever may be the faith of the public now, every successive failure will weaken that faith, and the chance of any other company being successful will in the future be lessened. Personally I should be very pleased, and so no doubt would my brother Directors, to get rid of the trouble and anxiety which attend the performance of our duties as Directors of this Company. We have attended to those duties really for more than a year without fee or reward. We cannot, however, retire from our position in the way now proposed. We take a different ground. We suggest the way we should do it, but we do not accept, and do not believe the required majority will accept, the proposal to wipe out the Company in the way proposed. I would now leave any one of the malcontents to move the resolutions of which they have given notice.

In reply to Mr. LEE,

The CHAIRMAN stated that the requisition had been signed by shareholders of quite sufficient holding for the purpose.

Mr. W. HEWETT, junior, said he would not waste their time by going over the ground which had been already covered. The directors and the shareholders, as represented by the requisitionists, were at issue as to the management of the Company, and especially in connection with the Colchester business. The requisitionists held a considerable number of the shares. He held 500 shares. His friend, Mr. Reginald Braithwaite, held 1,500, and altogether they had a considerable number of the shareholders with them.

Mr. LEE: Mr. Braithwaite was the original broker of the Company.

Mr. HEWETT repeated that it was not worth while going over the ground. Mr. Fry, however, had referred to what was said at the last meeting—that the Brush Company would not look at their assets. As to that he thought that the Directors were perfectly well aware that the Company parted with their interest to the Brush Company some time ago, and they had nothing therefore to offer to that company. (The Chairman dissented.) As for the Colchester installation, he would only ask them as men of business if they could expect any sane man to buy a thing which was a dead loss of £1,000 a year at once, and situated in a country town where they could have no possible prospect of getting a sufficient number of lights to pay them. It was an ill-judged thing to go Colchester, and he believed that the Board were now aware that that was so. If they were not the shareholders, at all events, were. He concluded by moving the first resolution, for the voluntary winding up of the Company.

Mr. NOEL seconded the motion.

Mr. OFFOR thought the Chairman would allow him to explain the nature of the agreement made by the Company with the Brush Corporation, and which had been termed the selling of their birthright. The agreement made was this: Under their original arrangement they had the exclusive right of selling the Brush patents in the three counties of Kent, Surrey, and Essex, and they were to receive 20 per cent. discount on anything they sold. They were, however, prevented by that agreement from dealing in any other dynamo machines or lamps except those under the Brush patents. They were therefore restricted entirely in their business to the Brush patents. The new arrangement they made with the Brush Company was this: In the first place, that Company increased the discount allowed by them from 20 per cent. by an additional 10 per cent. on anything they sold under the Brush patents. They had also given them the privilege of purchasing dynamos or lamps from anyone else, so that if they had a customer who preferred a dynamo machine or lamp of another maker the Company were not prevented from getting their profit out of that transaction. In exchange for these advantages they had allowed the Brush Corporation to sell in the districts of this Company, subject to their giving the Company a commission of 10 per cent. The opinion of the Directors was, that so far from that arrangement being a selling of their birthright, it was an absolute advantage to the Company in having made the new agreement.

Mr. BLEWITT said that the shareholders would perhaps let him explain that the advantage to the shareholders of having got rid of the first arrangement with the Brush Corporation was that the Company had made a capital expenditure of over £7,000 and incurred an annual loss of £1,000.

The CHAIRMAN: That is not an explanation; it is a statement.

Mr. LEE said he would not move an amendment or anything of that kind, as they could express their dissent by a negative. He thought, however, it was simply due to the Directors to say—as they were all of them aware—that the Company was engaged in a new industry, and that

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the Board had had, in conjunction with all the companies, very considerable difficulties to contend with.

Mr. BROOKER: Oh, we have heard all that before.

The CHAIRMAN: Go on, Mr. Lee. He is perfectly harmless.

MR. BROOKER: Some of the mud will stick.

Mr. LEE (continuing) said he was simply an original shareholder, and he held only 25 shares. He had lost a great deal of money in connection with the other companies. He hoped to live to see a considerable development of electric lighting, and with respect to that desire he thought he had been helped considerably by the South Eastern Brush Company, more particularly in connection with the despised Colchester installation. He desired to get as much of his money back as he could if the concern went into liquidation, or he was quite content to sacrifice what he had lost or might lose so that he might have the opportunity of seeing a very considerable development of electric lighting. He thought that some of the shareholders had been rather misled —he, for one, had been very considerably—in taking up shares in the Company by the highly respectable brokers whose names appeared in the prospectus (Messrs. Foster, Braithwaite and Co.) He had known that firm for many years, and he believed if they were to canvass all the original shareholders it would be found that the name of the firm had been a considerable inducement to take up the shares. Fortunately he was not a large shareholder, whereas he understood that Mr. Braithwaite was interested to a very large extent. At the same time it seemed to him a little out of place for one of the principal promoters of the Company [No, no] to be one of the requisitionists. He said advisedly a promoter, for he considered that everyone whose name appeared on the prospectus was a promoter of the Company. He wanted to see the electric light develop, and he intended to vote against the resolution, not so much, perhaps, in his own interest as in the interest of electric lighting.

Mr. C. H. STEWART said he was not one of those who wished to treat lightly the assets of this Company, and if he were appointed one of the liquidators he would do his utmost to get the outside sum possible from the parent Company. He would also take steps to try to sell the Colchester installation, either to the Corporation, the gas company, or to a private company. He believed that the sooner the Company was wound up the better. That proceeding, he maintained, would not interfere in the least with the course of electric lighting. He had been informed by the manager—whose knowledge of electric lighting he regarded as second to none—that if the two companies were disposed of [referring to the South Eastern and the Provincial Companies] he could do as much business with the Consolidated Company as with them. Besides all that the South Eastern Company was denuded of capital. It had been handed over to the Consolidated Company. They had only 7s. 6d. a share to call up. Where were their means to extend electric lighting? It was their interest to get all they could out of the Company. He said not a word against the Directors, who had come into the business in a somewhat similar way to himself. They had all been sufferers. No doubt the Directors were handsomely paid for two years, but it could not be expected that men of business would work unless they were paid. He hoped the Board would go with the requisitionists as to the liquidation of the Company, and follow with the Provincial Company in which they were all closely interested.

Mr. ALFRED W. LIGHTBODY said he believed the Anglo-American Brush Corporation had lately entered into certain arrangements with some of their subsidiary companies; he referred to the Great Western and the Midland Companies. The meeting had the advantage of having among them one of the Directors of the Brush Corporation, and he would like to ask whether any, and what, suggestions had been made by that Corporation for taking over this Company in the same way as they had taken over—or were about to take over—the businesses of the Great Western and the Midland Companies. He would also ask whether the Brush Corporation proposed any arrangement. Probably these questions could be easily answered by Mr. Braithwaite, and he thought the shareholders would like to have this information before they decided whether the Company should be wound up now, or whether that course should be taken after a certain period, which would give time for such arrangements as he had suggested with the Brush Corporation. If such arrangements were considered satisfactory, they could then be submitted to the shareholders to decide whether they should be carried out or not. The fact of the Company going into liquidation would, he thought, cramp its chances.

Mr. BRAITHWAITE: No.

The CHAIRMAN: Mr. Braithwaite is not an authority

Mr. LIGHTBODY maintained that a liquidation would cramp the chances of realising any assets which the Company might have. He feared that the assets were not very great, but for all that he did not see why all the assets, or the majority of them, should be spent in a liquidation of the Company. If there were a chance of realising the assets they possessed, he considered that the proceeds should go into the pockets of the shareholders.

The CHAIRMAN repeated that they had received a letter from the secretary of the Brush Corporation, and that they had an appointment with the Directors of that company for next Wednesday.

Mr. LIGHTBODY said he was only a very small shareholder, but he did feel an interest in the progress of the electric light.

Mr. JOSEPH BRAITHWAITE said it was quite true that an appointment had been made by the Directors to meet the Board of the Brush Corporation; but, as he stated at their last meeting, he was authorised to say that they saw no prospect of taking over this Company in the same way as the Great Western and the Midland Companies were taken over. The South Eastern Company had parted with their concessions, and the Great Western and the Midland Companies had not. He also wished to say that the Directors of the Brush Corporation would be much more ready—certainly quite as ready—to make an arrangement with the liquidators of the Company as with the Board. Speaking as a shareholder of the Company, and not as a Director of the Brush Corporation, he thought they would stand a better chance of recovering what was lost by acting with independent parties than with the Directors.

The CHAIRMAN asked Mr. Lightbody whether the act of going into liquidation would not cancel the licenses of the Company; and how in that case could they expect to get anything from the Brush Corporation?

Mr. LIGHTBODY thought that this view was substantially correct. He understood Mr. Braithwaite to say that the position of the South Eastern Company was different to that of the Great Western and the Midland Companies. He wished to ask whether it was not the fact, when the Brush Corporation entered into negotiations with the Great Western and the Midland Companies, that a similar arrangement—whereby their original licenses had been modified—had been entered into with the Great Western and the Midland Companies?

Mr. BRAITHWAITE stated that as he was Chairman of the Great Western Company, and was interested in the Midland Company, he could say that that was not the fact. He wished to add, speaking for the Directors of the Brush Company, that they would, in the event of any arrangement, give quite as favourable terms to the liquidators as to the present Board.

Admiral Sir E. A. INGLEFIELD asked whether it was not the fact that when they decided on liquidation their licences would become forfeited.

The CHAIRMAN replied in the affirmative.

Mr. BLEWITT said that the Board, as he understood, had already given a pledge that they would try and sell their concessions to the Brush Corporation, and the Colchester Installation, and failing that, that they would wind up. They would therefore go to the Brush Corporation and say: "We wish to sell you our concessions, and if you do not take them we shall wind up."

The CHAIRMAN: That does not follow, and if it did it falls short of winding up first and then going to the Brush Corporation.

Mr. DUFFIN would like to know, if the Brush Corporation (the parent company) had the full right of supply in the districts in which this Company worked—and for which they gave a large price—what was left of their concessions.

A DIRECTOR pointed out that the privilege of the Brush Corporation of selling in the districts of this Company was exercised subject to their paying this Company a commission of 10 per cent.

Mr. DUFFIN: Then practically they are worth nothing. We have given back what we purchased, and they will not give us anything for our assets.

The CHAIRMAN stated that he would now proceed to take the vote on the first question, and in taking the division he must have due regard to the proportion of votes given. It would require a majority of three-fourths of the votes; but there could be a poll. He then put the resolution, in favour of which eleven voted, eight being against it. He, however, declared it lost, and a poll was demanded.

In reply to a question by Mr. BLEWITT,

The CHAIRMAN stated that he should rule that if the first resolution were carried the second resolution would require the same majority of three-fourths of the votes.

Mr. BLEWITT observed that over and over again at meetings called for winding up liquidators had been appointed by a bare majority.

Mr. HEWETT then proposed the second resolution, appointing Messrs. C. H. Stewart and A. L. Riddell liquidators. He would only remark that his friend, Mr. Stewart, was successful as liquidator of the Great Western Company in returning the shareholders a great deal more than they were ever likely to get out of this Company.

Mr. NOEL seconded the motion.

The CHAIRMAN put it, and announced that twelve had voted for it and six against it. He, however, as before, on the same principle, declared it lost, and announced that they would now proceed to the poll.

Mr. BLEWITT presumed that the Chairman already knew pretty well what the result of the poll would be.

The CHAIRMAN: Yes; but we had better go to the poll. There are represented 11,522 shares. You hold proxies for 6,965, and the Directors have proxies for 4,557.

Admiral Sir E. A. INGLEFIELD asked whether the Directors would agree on behalf of the shareholders to allow one of the members present to join them as a liquidator, and as a sort of guarantee to them that they should know what was going on at the Board, and have some voice. As matters now stood, the Directors had appointed themselves as liquidators.

The CHAIRMAN: No; this will have to be gone over again.

Admiral INGLEFIELD: Who are the liquidators if you wind up?

The CHAIRMAN: Personally, if it goes into liquidation I would rather leave it to some one outside. I do not speak for the Board generally.

Mr. LIGHTBODY thought the Directors should be very pleased indeed to have some one of the opposing shareholders among them.

The CHAIRMAN: We have met the committee of investigation, and Mr. Stewart will bear me out in saying that the Directors were ready to do that—to join with them, and that he and I should be the liquidators; but instead of seeing us again on the subject they sent out this requisition.

Mr. STEWART observed that, so far as he was personally concerned, he would have been pleased with that. He thought it ought to be understood that the Company would be liquidated, and that no further calls would be made.

The CHAIRMAN: I make no promise on that. You may have driven us to it.

A SHAREHOLDER: Do I understand that you are not pledged to the liquidation of the Company?

The CHAIRMAN: You need not understand anything beyond what has been pledged to you.

A SHAREHOLDER: Assuming that the resolution for the liquidation of the Company is lost, are you going to wind up the Company?

The CHAIRMAN: We have said so. It comes to that, but we do not do it it in the way now proposed.

Admiral INGLEFIELD: Is it not the case, notwithstanding these meetings, that this Company will go on as if there had been no committee?

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The CHAIRMAN: Certainly not. We are going to the Brush Corporation, and we are going to deal with people to sell the Colchester installation.

Mr. LIGHTBODY asked whether the Directors still held to what they had said in their circular. That said:—"The Directors repeat, and are ready to fulfil, the pledge given by them in their circular of the 21st ult., viz.: 'To use their best endeavours to make terms with the Anglo-American Brush Corporation; to try to sell the Colchester Installation as a going concern; or, with the consent of the Board of Trade, to remove the plant elsewhere; and then, at an early date, to wind up the Company voluntarily.'"

The CHAIRMAN: Yes, as early as possible.

Mr. LIGHTBODY: That means to say within a reasonable time.

The CHAIRMAN: If we fail in the course of a few weeks to do anything else, we must proceed to wind up.

Mr. BLEWITT said the Directors would pledge themselves to no date.

The CHAIRMAN: We could not; we are under contracts, and so on.

The poll was then taken, and on the return of the scrutineers,

Mr. BLEWITT said that according to his calculation the requisionists wanted 8,013 votes to have the required majority, and they had obtained 6,965.

The CHAIRMAN said that they claimed 450 more, but as it did not affect the position the matter was of no consequence.

Mr. BLEWITT: This claim is not allowed, because I say that persons who have given bills for calls have not paid them.

The CHAIRMAN: If we give them up it does not affect the question. On this result, accepting Mr. Blewitt's figures, I declare the resolution lost, there not being the required majority.

Mr. NOEL: The result is that the Directors, being in a minority of some 3,000 votes, elect to remain on the Board.

The proceedings then terminated.

Australasian Electric Light, Power, and Storage Company.

As reported in our last issue, the result of the meeting of the above Company, on the 9th inst., was a demand for a poll on the motion for the adoption of the report and accounts. It was arranged that the poll should be taken on the 16th inst., which was done. The report of the scrutineers, Mr. J. H. Duncan (the Secretary of the Company) and Mr. R. E. Stephens, has just been circulated among the shareholders, from which it appears that the result of the poll was as follows:—In favour of the Chairman's motion, 13,406 shares, entitled to 13,146 votes; against it, 1,010 shares, entitled to 1,010 votes, showing a majority in favour of the motion of 12,396 shares, entitled to 12,136 votes. In favour of the motion were included 3,663 vendors' shares. The scrutineers had rejected as invalid, through informality of proxy, 1,697 votes in favour of the motion, and 2,057 votes against it. In a circular accompanying this report Mr. Duncan, on behalf of the Directors, points out that the result of the poll gives a majority for the Board of 12,136 votes, or of 11,776, "if all the invalidated votes be taken into account. The Directors, in announcing the result of the poll, desire me to thank the shareholders for the strong support given to them." The circular adds:—"The original Directors repeat their regret that the committee, although nominated as a consultative body, formed their conclusions without conference with the Directors, without affording them the opportunity of giving any explanations, and without perusing the correspondence. They willingly accept the statement of the committee that this was done in the exercise of their best judgment as to the intention of their appointment. Their report thus assumed, however, an *ex parte* character, and the Directors, therefore, did not feel it incumbent on them to act upon their suggestions. The poll just taken having now disposed of the recommendations of the committee, I am desired to add that the original Directors take this opportunity of carrying out their repeatedly-expressed intention of dealing with the question of the fees standing in the suspense account, which have now been entirely written off, and the same principle will of course guide the Directors in the future."

The German Union Telegraph and Trust Company (Limited).

Report of the Directors to be presented to the shareholders at the fourteenth ordinary general meeting on the 25th inst:—The Directors beg to submit the accounts and balance-sheet for the twelve months, ending 31st December, 1884, including in the accounts the coupon in respect of that period just received from the German Union Company of Berlin. The total receipts during the twelve months amount to £12,460 6s. 2d., which, with a balance of £1 15s. 1d. brought forward from last account, make a total of £12,462 1s. 3d. The expenses for the same period amount to £786 18s. 6d.; of this sum £750 is provided by the German Union Company of Berlin. Out of the receipts an interim dividend of 5s. 9d. per share was distributed on the 20th January last, and the Directors recommend the payment of a further dividend of 5s. 6d. per share, making a total distribution for the year of 11s. 3d. per share, free of income tax, or at the rate of £5 12s. 6d. per centum per annum, as against £5 17s. 6d. paid last year, leaving a balance of £155 7s. 9d. to be carried over to the next acccount. Although the traffic has shown a small increase in the number of telegrams during 1884, there has been a decrease in the average number of words contained in each message, a condition of things which has been experienced by all Submarine Telegraph Companies. The decrease in the number of words has produced a diminution in the receipts, which is not compensated for by the increase in the number of telegrams sent. The cables are in good working order. The establishment of a repeating station at Lowestoft has proved of great advantage in facilitating telegraphic traffic between Germany and Great Britain. With the additions made annually to the reserve and renewal funds of the Berlin Company, these items now stand at over £50,000. Further accumulations to these funds will give a reserve, which will be a solid basis for the Company's future. According to the Articles of Association, Count Oscar von Reichenbach, one of the Directors of the Company, retires by rotation, and offers himself for re-elecion. The auditor, Mr. Henry Dever, also retires, and offers himself for re-election.

Messrs. Glover and Co.—We are requested to mention that on the 20th instant Messrs. Walter T. Glover and Co., electrical wire and cable makers, removed from their present city offices at 25, Booth Street, Manchester, to their new and commodious offices in close proximity to their Bridgewater-street, Broughton-road, Salford Electric Wire Works, Springfield Lane Cable Works, Salford. Their new postal address will be "Walter T. Glover and Co., Salford, Manchester."

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. MAR. 18.		BUSINESS DONE WEEK ENDING MAR. 18. Highest.		Lowest.	
Anglo-American	29½,	30½	.....	30½	.....	29½
Do. Preferred	53½,	54½	.....	54½	.....	53½
Do. Deferred	7,	7½	.....	7½	.....	7
Brazilian Submarine	11½,	11⅝	.....	11⅝	.....	11 5-16
Cuba	10⅞,	11½	.....	—	.....	—
Do. Preference	17,	18	.....	17½	.....	—
Direct Spanish	1⅞,	2½	.....	—	.....	—
Do. Preference	10½,	11½	.....	—	.....	—
Direct United States Cable	9⅜,	9⅝	.....	9 13-16	.....	9 11-16
Eastern Telegraph	11⅞,	12⅛	.....	12⅛	.....	11⅞
Do. 6 per Cent. Preference	13½,	14	.....	13 15-16	.....	—
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	12¾,	13	.....	13	.....	12¾
German Union	9½,	10	.....	9¾	.....	—
Globe Telegraph and Trust	6¾,	7	.....	7	.....	6 13-16
Do. Preference	12¾,	13	.....	13	.....	12¾
Great Northern	14¾,	15	.....	15	.....	—
Indo-European	32,	33	.....	32	.....	—
Reuter's	7½,	8	.....	—	.....	—
Submarine	180,	190	.....	—	.....	—
West India and Panama	⅝,	¾	.....	—	.....	—
Do. 1st Preference	7½,	7¾	.....	7½	.....	—
Western Brazilian	6½,	6½	.....	6½	.....	—
Western Union 7 per Cent. 1st Mortgage	120,	125	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	.....	—	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	½,	⅝	.....	—	.....	—
Oriental	½,	⅝	.....	—	.....	—
United Telephone	10¼,	11¼	.....	11 1-16	.....	10¾

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞	.....	—	.....	—
Do. (fully paid)	2¾,	3¼	.....	—	.....	—
Hammond Light (£3 15s. paid)	⅜,	⅝	.....	½	.....	7-16
Swan	½,	¾	.....	—	.....	—
Maxim-Weston	3-16,	5-16	.....	—	.....	—

MISCELLANEOUS.

Telegraph Construction	32½,	34½	.....	34½	.....	33¾
India Rubber, Gutta Percha, and Telegraph Works	19½,	20½	.....	20½	.....	20¼

TRAFFIC RECEIPTS FOR FEBRUARY, 1885.

COMPANIES.	Feb., 1885.	Feb., 1884.	Increase.	Decrease.
Cuba Submarine	2,700	3,099	—	399
Direct Spanish Telegraph	1,457	1,588	—	131
Direct United States	—	—	—	—
Eastern Extension	40,114	38,900	1,214	—
Eastern Telegraph	61,784	57,396	4,388	—
Great Northern	20,400	—	—	—
Submarine	—	—	—	—

PRACTICAL ELECTRICIAN REQUIRED to take charge of the Electrical Department of the ÆOLUS WATERSPRAY COMPANY.—Apply personally, with testimonials, at 235, High Holborn, before 12 o'clock.

ELECTRICAL.—WANTED, a Gentleman understanding Electrical matters, to join Advertiser in FITTING UP a SMALL FACTORY for Electrical Apparatus abroad, on the Mediterranean. Magnificent climate. An Engineer or Experienced Man preferred. Capital required, £1,000.—Address, PIONEER, at Horncastle's Central Advertisement Offices, 61, Cheapside, London, E.C.

ELECTRICAL ENGINEER is DISENGAGED. Has had considerable experience in Electric Light Installations, Land and Ship, in manufacture of Dynamos, Accumulators, &c.—Address S. J., *The Electrician* Office.

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NOTES.

ELECTRICITY IN AMERICA.—Last year's patents granted in the United States numbered 18,799, of which 1,166 were for electrical inventions.

ELECTRIC LIGHTING AT VIENNA.—The *Wiener Zeitung* announces that M. Fischer has obtained a concession for a central electric lighting station in that city.

TELEGRAPHIC EXTENSION IN LEEDS.—The Post Office authorities are about to establish telegraphic communication between Featherstone Station and the Purston Post Office.

THE CONTROL OF TELEPHONE AND TELEGRAPH WIRES.—We think it better, in the interest of our readers, to give a *resumé* of the proceedings of the committee on this question at the conclusion of the inquiry.

ITALY AND THE RED SEA.—The Italian Minister of War has ordered seven telephonic apparatus to be sent to Massowah to open a communication between the Commander-in-Chief of the expedition and the advanced forts.

SMELTING BY ELECTRICITY.—We are informed that an American engineer has succeeded in evolving a process by which gold, silver and copper can be instantly smelted from concentrations by electric currents of high tension.

THE TELEPHONE AT SAN DOMINGO.—A telephone exchange is about to be established in Puerto Plata. Only copper wire will be used in the establishment of the telephone plant, iron or steel wire being considered unsuitable for the climate.

THE NEW BRIDGE OVER THE GANGES.—The electric light has been adopted by the engineers engaged in the construction of the Gandak Bridge, in order that the work may not be interrupted by the want of an efficient illuminant at nightfall.

THE ANTWERP INTERNATIONAL EXHIBITION. — Messrs. Siemens and Halske, of Berlin, have offered to illuminate the German Section gratuitously by the electric light; and others will light the machine gallery, the central gallery, and the gardens.

THE TELEPHONE IN BATH.—The lessee of the Bath Theatre has consented to allow the committee of the Industrial and Fine Arts Exhibition to place the telephone apparatus upon the theatre stage, which it is proposed to connect to the exhibition building.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 20th March were £2,562, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

"SELL'S DICTIONARY OF [THE WORLD'S PRESS."—Mr. Henry Sell has just issued the 1885 edition of his handy book of reference. It abounds in practical advice to pressmen, to advertisers, and to those of the general public who are interested in journalism.

THE ELECTRIC LIGHT IN NEW ENGLAND.—The American Electric and Illuminating Company have combined with the Edison people, and are to use the Edison incandescent system for isolated lighting in connection with all of their arc lighting stations in New England.

ANOTHER INSTALLATION.—Messrs. S. W. Silver and Co. announce that the rebuilding of their warehouse in Cornhill is now completed, and that their address is again Sun-court, 67, Cornhill, London, E.C. The new building will be lighted throughout with the electric light.

THE ELECTRIC LIGHT AND WARFARE.—*The Times* correspondent, telegraphing from Suakin on Monday, says:—"The electric light from the 'Dolphin' in the harbour, six miles away, is visible at intervals. As its long and brilliant beam sweeps around the plain and over us it cheers our hearts."

ELECTRIC LIGHTING FOR MINES.—In some experiments carried out by the officers of the Regimental School in Versailles it was shown that the incandescent lamps used in the lighting of subterranean passages were capable of resisting the concussion caused by the explosion of 500 kilog. (1,100lb.) of powder.

THE PROGRESS OF CIVILISATION IN THE SOUDAN.—Shortly after the correspondent of the *Daily Chronicle* got his first message through from the field on Monday the wire was cut in no fewer than six places by the rebels in the rear, who had not previously been accredited with knowing anything about the uses of a field telegraph.

THE CABLE SHIP "MACKAY-BENNETT."—This steamer has recently passed through the centre of a terrible hurricane, which lasted six hours. The officers unite in declaring her to be a handsome craft and a magnificent sea boat, and one of the finest specimens of modern marine architecture. She steams 11 to 12 knots an hour.

THE SNOW STORM.—Considerable damage was done on the 22nd by the snow in the neighbourhood of Portsmouth, particularly to the telegraph wires. All communication with the west of England was temporarily cut off, nearly every wire leading out of Portsmouth was broken, and in some instances iron telephone poles were snapped.

THE EARTH'S MAGNETISM.—Gaus, the illustrious German astronomer, has computed the attracting or lifting power of the earth at 42,310,000,000,000,000,000 tons. If this magnetism were equally distributed throughout the mass of the earth, the magnetic intensity of each cubic yard would be equal to about 60lb. attractive force.

TELEGRAPHIC FACILITIES IN GERMANY. — The German Postmaster-General has introduced another practical innovation, namely, that of allowing telegrams to be thrown into the letter-boxes, more especially those attached to mail cars on railway trains. It is only necessary to write out the message, mark it "telegram," and attach the tariff rate in postage stamps.

THE WHISTLING NUISANCE.—The General Manager of the London and Brighton Railway Company has introduced a system of electric communication between the platforms and the signal boxes at the Brighton Station, whereby the succession of loud locomotive whistles incidental to the starting of particular trains is entirely obviated. We hope to see the system extended.

NEW CATALOGUE.—Messrs. Weedon and Irish, electric engineers, of Sunderland, have just issued a catalogue of electrical appliances. It is well arranged, and contains an abundance of information, which will be found of considerable value to those in particular who are interested in the latest and most approved electrical inventions. There are numerous illustrations, and full price lists.

EARTHQUAKES AND EXPLOSIONS IN MINES.—Herr Rudolph Jall, the well-known geologist, who has made a special study of volcanic eruptions, publishes a caution to mine overseers. He says that explosions in mines usually coincide with, or follow close upon, earthquakes; and he mentions as days that will be dangerous in mines this year, all over Europe

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March 30th, June 12th, July 12th, September 8th, and September 24th.

THE EASTERN TELEGRAPH COMPANY.—The Eastern Telegraph Company announce the payment on 14th April next of a dividend of 3s. per share on the preference shares of the company, less income tax, for the quarter ending 31st March, 1885; and that an interim dividend of 2s. 6d. per share on the ordinary shares of the company, free of income tax, in respect of profits for the quarter ended 31st December, 1884, will be paid on the same day.

THE ELECTRIC LIGHT IN AMERICA.—It is said that a new company, the American Electric Manufacturing Company, with a capital of £600,000, divided into 30,000 shares of £20 each, is about to be incorporated by charter taken out under the laws of the New York State. This company will absorb the business of the American Electric and Illuminating Company and that of the Boulton Carbon Company, together with other important electrical interests.

ELECTRICAL LEADS IN PHILADELPHIA.—At the close of the year there were on the highways of the city of Philadelphia 4,631 poles, exclusive of those along the lines of railroads; 4,499 miles of telegraph and telephone wires, 115 miles of electric light wires, and 341½ miles of underground wires. Belonging to the city there are 3,449 poles and 411 miles of telegraph wire, making a grand total of city and other overhead wires of 5,025 miles and 8,080 poles.

ANGLO-AMERICAN TELEGRAPH COMPANY.—The Board of Directors of the Anglo-American Telegraph Company have resolved (after placing the sum of £37,500 to the credit of the renewal fund) to declare an interim dividend for the quarter ending 31st March, 1885, of 4s. per cent. on the ordinary stock, and 8s. per cent. on the preferred stock, less income tax, payable on the 1st May to the stockholders registered on the books of the company on the 31st March, 1885.

A NOVEL INCANDESCENT LAMP.—A rather novel feature of one pattern of the Perkins incandescent lamp, which is now in use in some parts of America, is the arrangement of four carbon loops, which by means of a rotating switch can be made to give the light of one or more of these at the same time. The carbons are mounted in multiple arc within the globe This form is arranged for and used as a desk or table lamp, and the burning out of one of the carbons does not affect the remaining three.

THE ELECTRIC LIGHT IN GERMANY.—Judgment has been given in the action between Naglo Brothers and Eisenmann, proprietors of the Swan lamp, and the Edison Company, in favour of the latter. An injunction has been granted interdicting the construction and the sale of the Swan lamps in the German Empire. This decision, if it remains in force, will have a considerable effect upon the development of electric lighting in that country; and it certainly places the Edison Company in a very enviable position.

THE TELEPHONE IN SPAIN.—The telephonic service in Madrid has recently received considerable additions. At the date of the 1st of March there were already 80 places connected with the central station. It is said that the director of the Theatre Royal has decided to establish telephonic communication between the theatre and the houses of those who desire to partake of the pleasures of the opera. The subscription has been fixed at 500f. per annum. A hall will also be arranged for in the centre of the town where the public may hear the music.

SIXPENNY TELEGRAMS.—Down to the time of our going to press the Postmaster-General had not made his promised statement as to the Government proposals with regard to the new telegraph tariff, which is to come into operation in August next. But we understand that the decision arrived at is to charge for every word, addresses as well as text, at the rate of a halfpenny per word; or rather a penny for every two words, the charge progressing by pennies, not halfpennies. Thus, twelve words will cost sixpence, thirteen (or fourteen) sevenpence, and so on.

ELECTRIC TRAMWAYS IN AMERICA.—Our contemporary, the *Electrical World*, furnishes us with the agreeable intelligence that:—"One by one, street car companies in various parts of the country are adopting electric motors to replace horses. The Cleveland service is a success. A Daft plant has been furnished for a line in Baltimore, and we now hear that the Van Depoele Electric Manufacturing Company have sold an outfit for ten miles of street railway in Kansas City, Mo. The company are very sanguine about a rapid development of this part of their business."

THE ELECTRIC LIGHT ON BOARD THE "OCEANIEN."—The new packet boat of the company Messageries Maritimes has received an installation of 16 candle-power Edison incandescent lamps, which will light up the cabins, the saloons, and every other part of the interior of the vessel. For the decks, and for nightwork, lamps of 400 candle-power, and arcs of about 1,100 candle-power will be used. Messrs. Sautter and Lemonnier have furnished a steam motor of the system Wègy, which has a speed of 750 revolutions a minute. The two dynamos are of the Gramme system, with compound winding.

THE LIVERPOOL ELECTRIC SUPPLY COMPANY.—The directors of this company state in their annual report that the profits of the twelve months ended December 31, 1884, enable them to recommend a dividend at the rate of 5 per cent. per annum, after providing for all contingencies, and setting aside £150 for reserve fund. The dividend for the previous year (1883) was also 5 per cent. During the last few months the number of electric lamps supplied from the company's central station, in Elliot-street, has been very largely increased, the advantage of which will be felt in the augmented rental receipts of the current year.

THE CITY AND GUILDS OF LONDON INSTITUTE.—Examinations in technology will take place at the different provincial centres throughout the kingdom on Wednesday evening, May 20th, 1885, at seven o'clock. Individual candidates who are unable to arrange to be examined at a provincial science centre can, on application to the director and secretary, be examined in London at the Cowper-street Schools, E.C. The examination will be held in forty-seven subjects. A programme, containing syllabus of each subject and last year's examination questions, can be obtained from the office of the institute, Gresham College, London, E.C.

INFLUENCE OF MAGNETISATION ON THE CONDUCTIVITY OF MAGNETIC LIQUIDS.—Former experiments on the influence of magnetisation on the resistance of magnetic liquids have led to negative results. An account, however, has been given of an investigation on the effect produced by the magnetisation of ferrous sulphate as regards its electric conductivity. It would appear, so far as the experiments permit of a conclusion, that if the lines of the magnetic field are normal to the direction of the electric current, no effect is produced; but if the two are parallel to one another, the electric conductivity is increased, and eventually the E.M.F. of the polarisation of the liquid appears to be diminished.

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ELECTRIC LIGHTING OF TRAINS.—The engines used for the electric lighting of trains on the Great Eastern Railway have continued running since October, 1884, with perfectly satisfactory results. The engine was coupled direct to its dynamo, specially made, the two being together on one bedplate. The whole was mounted on the top of the locomotive boiler behind the dome, so that it occupied no space on the footplate, and the steam could be taken direct from the dome. The regular speed was between 1,000 and 1,100 revolutions per minute. The light has never gone out once during the five months it has been employed. This is a great point in its favour, for it is most important that a light on an engine should not be extinguished, even for a few seconds.

THE ELECTRIC LIGHT IN PARIS.—It is said that the University of Paris has at last decided to introduce electric lighting in all its establishments. The Edison Company are about to lay down an installation of 550 incandescent lamps in the Lycèe Louis-le-Grand. The motive force will be furnished by two gas motors. As has been already announced, the incandescent light is in full operation at the Hippodrome. Besides the Serrin regulators and the Jablochkoff candles, which have been some years in existence, that immense building has received an addition of 800 Swan lamps, supplied by two Edison dynamos of 300 amperes and of 65 volts. These lamps have replaced the gas burners, and the effect produced is, it is scarcely necessary to observe, very satisfactory.

THE EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—This company to December 31st last show, subject to audit, a balance of profit of £110,126, after payment of three interim dividends and a bonus of 2s. per share for the first half year, and charging £42,767 against revenue during the year on account of cable renewals. The directors now propose to pay on the 30th proximo the usual dividend of 2s. 6d. per share, together with a bonus of 2s. per share, making, with previous distributions, a total payment of 7 per cent. for the year 1884.—This company announce the numbers of 433 Five per Cent. Debentures (1880 issue) of £100 each, which have been drawn for payment at par on 1st May at the Consolidated Bank, 52, Threadneedle-street, after which date interest on them will cease. The numbers will be found in our advertisement columns.

ELECTRIC LIGHTING AT LIVERSEDGE.—Messrs. Crooke, Son, and Co. have just completed an arc electric light installation in their large dyehouse with the most successful results. Jarman arc lamps of 2,000 standard candle-power each have been utilised, and give a very powerful and brilliant white light. Colour matching, we are informed, is done by means of this light equally as well as by daylight. The lamps are worked from a Jarman patent shunt-wound dynamo, giving a current of 10 amperes and 110 volts. The working parts of the lamps are completely protected from the vapours of the dyehouse by means of a specially constructed lamp case, and this prevents any of the metal parts from corroding or short-circuiting. Mr. W. B. Hutchinson, C.E., of Market-street, Heckmondwike, has directed the satisfactory carrying out of the installation.—*Gas and Water Review.*

ELECTRICAL TRAINING FOR SOLDIERS.—It is rather a remarkable fact that when it was proposed to organise an additional section of the 1st Division Telegraph Troop it became necessary to draw upon the postal service throughout the kingdom. It seems to have been more by luck than War Office judgment that the telegraphists lately sent out were ready to hand when required. The War Office, it is said, had nothing to do with their training, but the officers of a few regiments a little time ago sent a few intelligent men to the school in which the Post Office *employés* are trained, and thus some extra men were got ready. We have already advocated the establishment of a military school of telegraphy, not only for the Engineers, but for other branches of the service; and it is difficult to see how, if that service is to be an efficient one, the authorities can avoid the demand made upon them.

THE ELECTRIC LIGHT IN FRANCE.—A company recently organised in Paris will run a number of small steamboats (bateaux-mouches) on the Seine, thirty-two in number, which will be lighted by electricity. Each will have twenty-two incandescent lamps of 16 candle-power. The power will be furnished for each installation by a steam engine of 5½ horse-power. The dynamo is of the Gramme type (Rafford modification), running at a speed of 150 revolutions per minute, giving a current of 18 amperes at an E.M.F. of 110 volts. The dynamo also supplies current for the signal light, consisting of a powerful reflector, with one incandescent lamp before it. The firm of Breguet has undertaken the installations. Two French steamers, "Château Yquem" and "Château Margaux," which have recently been chartered to transport French troops to Tonquin, are also lighted by electricity. Each has about 200 lamps on board, put in by the same firm.

THE ELECTRIC LIGHT IN THE HOUSE OF COMMONS.—While the authorities of the House of Commons have deferred their final report upon the value of electricity as compared with gas for use in the lobbies of the House and within the Chamber itself, the reporters of the evening papers, who prepare their copy in the little ante-room at the back of the Reporters' Gallery, speak in terms of the highest praise regarding it. There are two small incandescent lamps with the usual switching arrangements, and each covered with a lacquered green shade which throws a diffused and agreeable light upon the small desk over which they are suspended. So good is the light that not a few gentlemen have expressed the desire that it might be extended to No. 18 Committee Room, which is used during the sitting of the House by the staffs of the morning papers, and which becomes insupportably hot in the summer months in consequence of the great heat given out by the large candle lamps now in vogue.

A NEW ELECTRICAL ENGRAVING MACHINE.—Lieutenant Buller Carter, R.N., of 27, Bow-lane, London, has invented an engraving machine, in which the delicate agency of electricity has been introduced into the mechanism with great success. It is intended for decorative engraving upon metal work. The letterpress or design to be engraved is first furnished by a setting of ornamental types or a stereotype plate. Over this is passed in parallel lines an arm of the machine, to which is attached a fine platinum point. The motion of the arm is responded to by that of the table, which carries the metal to be inscribed or decorated beneath the point of the engraver. The types or stereotype plate, by raising the platinum point, puts into circuit a current of electricity, which, acting upon an electro-magnet, raises or depresses the graver, and produces an enlarged or reduced engraved copy of the types, upon the metal on the table, with perfect accuracy, and at a trifling cost.

THE ALEXANDRA PALACE.—The present lessees of the Alexandra Palace have now a large staff of workmen engaged in making the necessary preparations for the opening on the 31st of this month. The grounds are being put in order, and spaces are being arranged for the numberless stall-keepers. Besides this there are some three or four hundred men engaged by the Gülcher Electric Light Company in fitting up apparatus both inside and outside the building. The Grove is to be lighted with electricity, and it is proposed to hold

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concerts there throughout the season. The theatre, which has been rented by Messrs. Paget and Warne, will be lighted by electricity, as will also be the Oriental and English fairs, which the present proprietors regard as being the leading features of the show. An electric railway, which is to be run under the direction of Mr. Binko, is also regarded as another attraction. The New Bungalow Orchestra in the conservatory has also been fittedwith incandescent lights.

PROFESSOR WHEATSTONE AND LORD PALMERSTON.—The following anecdote, which we quote from the *Standard*, is fairly amusing:—"Lord Palmerston was one of the eminent men who had received his degree in the morning; and, standing at a little distance, I watched him as he listened to a somewhat prolonged exposition by Professor Wheatstone of certain new devices he had been busied with for the application of telegraphy. The man of science was slow, the man of the world seemed attentive; the man of science was copious, the man of the world let nothing escape him; the man of science unfolded the anticipated results—another and another, the man of the world listened with all his ears; and I was saying to myself, 'His patience is exemplary, but will it last for ever?' when I heard the issue:—'God bless my soul, you don't say so! I must get you to tell that to the Lord Chancellor.' And the man of the world took the man of science to another part of the room, hooked him on to Lord Westbury, and bounded away like a horse let loose in a pasture."

THE DELANY FAC-SIMILE TELEGRAPH.—This apparatus, to which we alluded in a previous issue as being adapted for the transmission of the Chinese language, has lately been practically applied to fac-simile transmission, whereby the hand writing of a correspondent, pen sketches, maps, plans, hieroglyphics, &c., can be sent over a single telegraph wire and reproduced at the receiving station with all their distinctive characteristics. Although other systems of fac-simile transmission have been tried, and fac-simile despatches have been sent and successfully reproduced, yet when but a single wire was employed, the time required for the transmission was so protracted, and the uncertainty of correct reproduction so great, that such systems of transmission could never come into actual commercial use. Mr. Delany's system, however, differs from all other systems of fac simile transmission in that it insures speed and certainty of correct reproduction. By means of the application of his synchronous system an area of twelve square inches can be covered in one minute by the use of a single wire.

THE WESTERN COUNTIES AND SOUTH WALES TELEPHONE COMPANY.—The Western Counties and South Wales Telephone Company has been formed to take over the rights and assets of the United Telephone Company in the following extensive district, comprising Cornwall, Devonshire, Somersetshire, Dorsetshire, the Channel Islands, Hampshire, the Isle of Wight, Wiltshire, Gloucestershire, Herefordshire, Monmouthshire, Glamorganshire, Carmarthenshire, Pembrokeshire, Cardiganshire, Brecknockshire, and Radnorshire, and all parts of Shropshire, Warwickshire, and Worcestershire as are not included within a twenty-mile radius from the General Post Offices at Birmingham and Wolverhampton respectively. The Post Office authorities have granted to the company a license which permits them to open exchanges at all places within this large and important district, and to connect the various cities and towns by trunk wires, and also—by agreement with the United Company and its subsidiary companies—to connect places in this district with those in any other district throughout the United Kingdom. They are also enabled to connect their exchange centres with the Post Office telegraphs, by which means subscribers may receive and forward their telegrams by telephone. Public call offices may be opened, wherein, upon payment of a small fee, the general public can communicate with any subscriber to the system.

LETTERS PATENT.—Our American namesake has an excellent article in its current number upon the defects of wording in patent specifications. Quite recently the Gold and Stock Telegraph Company applied for an injunction against the Commercial Company, alleging an infringement of one claim of the Colahan patent. This instrument is a type printer, with two parallel rotating wheels, one for printing letters of the alphabet, the other for printing numerals and fractions. "Each of these type wheels," says *The Electrician*, "advanced independently by a step-by-step motion communicated by an electro-magnet, ratchet, and pawl." The paper is forced upon the type by the action of a third electro-magnet. The claim alleged to be infringed is for "two or more type wheels, moving independently and controlled by magnetism, and arranged so as to print *jointly* or separately upon one slip of paper in two or more lines, substantially as specified." The weak point in the claim is the word we have italicised, the argument being that no one could tell what the patentee intended to claim from this wording—whether the apparatus claimed should print "jointly" or "separately," or both "jointly" or "separately," and so the injunction was refused. It has been our lot to examine many English specifications, and we fear if judges have to decide upon some patents, the wording will be found to attempt to include everything, and the patentee will find grasping everything means getting nothing.

NEW BOOKS.—We are in receipt of a comprehensive treatise upon "Electricity, and its Manner of Working in the Treatment of Disease," by Dr. W. E. Steavenson, to which is appended an inaugural medical dissertation on electricity for the degree of doctor of medicine in the University of Edinburgh, written in latin by Dr. Robert Steavenson in 1778, with a translation into English by the Rev. F. R. Steavenson, M.A. In the first portion of the work, which contains a variety of valuable information, we notice that in living nerve there is always a natural nerve current which can be detected by a galvanometer. The only change we are at present cognisant of as accompanying a nervous impulse is a negative variation of this natural nerve current. The rate of travelling of the negative variation along a nerve is 28 metres per second, and is identical with the rate of travelling of a nervous impulse. The negative variation passes in the form of a wave. The whole wave takes ·0007 of a second to pass any given point of a nerve. The length of the wave is 18 millimetres. Therefore a nervous impulse is a molecular disturbance propagated along the nerve in the form of a wave of the length of 18 millimetres, and possessing a velocity of 28 metres per second. Truly there are more things in Heaven and upon earth than are dreamt of in our philosophy. Were we not convinced of this fact we should hesitate to accept even the authority of Dr. Steavenson for the statement that "rubbing the soles of the feet a few times on the carpet will enable an inhabitant of the Southern States of America (query Canada?) to light the gas by the spark which will pass when he presents his finger to the metal point of a gas burner." However, whether that be open to discussion or not, the book is a very readable and a very interesting one, and is certainly a useful addition to our library.

THE DANGERS OF OVERHEAD WIRES.—A correspondent of the *Pall Mall Gazette*, on Monday last, writes as follows:—"For

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many months six telegraph wires have hung over Wimpole-street, crossing it obliquely from Wigmore-street to Queen Anne-street, a distance of about 120 yards. Soon after eight o'clock last Sunday morning, owing to the weight of tenacious half-thawed snow, one of these wires fell with a crash into the empty street. Two policemen quietly removed the broken wire, and without your assistance probably nothing more will be heard of the accident. Had the wire fallen on a week day, when carriages and foot passengers are about, severe injury must have been inflicted upon man or beast." Other correspondents, on Tuesday, afforded similar evidence. "M. H.," writing from North Hill House, Dartmouth Park Hill, says:—"An accident similar to the one recorded by your correspondent occurred during the snowstorm of Sunday, on Dartmouth Park Hill, N. One of the telegraph wires suspended over this frequented thoroughfare fell directly across the garden in front of this house, breaking in its passage a large pane of glass, and extending across the road. Two passers-by coiled it up in the garden, where it still remains." Mr. H. E. Harper writes from Coleherne-road, South Kensington, as follows:—"A similar accident to that described by your correspondent occurred in Coleherne-road, South Kensington, on Sunday. A number of telegraph wires cross that road obliquely, and on Sunday morning last one of them, broken doubtless by the snow, lay along the road for some hundred yards, and then upwards towards the roofs of the houses, thus, to say nothing of the danger in the sudden snapping of the wire, causing a most dangerous impediment to any driver in the dark. After lying in the snow for some considerable time, the wire was picked up by a half-frozen policeman, who considerately coiled it in a confused mass round some newly-painted railings. On passing along the Strand this morning, at the corner of Bedford-street I noticed another broken wire dangling in mid air."

Electric Lighting for Steamships.—During the discussion upon Mr. A. Jamieson's paper, read before the Society of Telegraph-Engineers, upon the subject of Electric Lighting for Steamships, Mr. R. E. Crompton remarked that the question of low speed dynamos for ships had excited the greatest interest amongst the manufacturers of these machines, and great progress had been made. Up to a recent period, modification of dynamos for ships' use, as usually carried out, consisted in winding on to the armature an increased number of coils, making a large machine do the work of a small one. This was not a scientific mode of solving the problem. If, when put into the form of a simple formula, where $E_a = \frac{r\,n\,a\,\mu}{1{,}000{,}000}$, E_a being the electromotive force in the armature in volts, r the revolutions per minute, n the number of turns of winding on the armature, a the area of cross section of the armature core, and μ a coefficient which depended on the intensity of the magnetic field through which the turns of wire n passed; evidently, if the revolutions per minute were to be kept small, the requisite E_a would be obtained—1st. By making a large, and this involved a large and expensive machine.—2nd. By making n large, which meant winding a great number of turns of thin wire on the armature—3rd. By making μ large, in other words increasing the strength of the magnetic field. Whenever sea going engineers insisted on the revolutions of the dynamos being kept down to 500 revolutions per minute, so that the dynamos could be coupled direct to the steam engines which drove them, the first two methods only were employed. It remained for Dr. Hopkinson and for himself to obtain the necessary electromotive force at the required low speed, by increasing the strength of the magnetic field. This had been arrived at by using both for field magnets and for the armature core a greatly increased mass of the softest and purest charcoal iron, and proportioning the parts composing the magnetic circuit so as to obtain the least possible resistance to the passage of the lines of force. This enabled machines to be constructed giving sufficient electromotive force for working the lamps at the comparatively low speed of 400 revolutions per minute, and still to maintain a high efficiency or high proportion of useful output. By the older plan of increasing the turns on the armature, the efficiency of some of the machines used in the Royal Navy and elsewhere was only as much as 50 or 55 per cent. In the latter improved machines the efficiency was as high as 84 per cent. at the same number of revolutions.

The Inventions Exhibition. — Electric Lighting Arrangements.—The arrangements for the lighting of the buildings and the grounds are being proceeded with. Some 18,000 incandescent lamps will take the place of the coloured oil lamps for the illumination of the grounds and the roof of the large conservatory. Within the building there are to be 464 arc and 5,530 incandescent lamps, or more than double the number used last year. The Lighting Committee is composed of Sir Frederick Bramwell, the Marquis of Hamilton, Sir Frederick Abel, Mr. W. H. Preece, Professor Dewar, Colonel Sir Francis Bolton (who again undertakes the direction of the illumination of the fountains), and Colonel Festing. Twenty-one systems of electric lighting will be shown, equal to the illumination of 533,000 candles. The arrangement of the systems is—Eastern Arcade and Western Avenue, Varley lights by Goulard and Gibbs; dining rooms (on the site of the dairies), Bernstein lights by Paterson and Cooper; Chinese restaurant, Gulcher and Woodhouse and Rawson lights; Old London, Mackie lamps, arranged to produce a moonlight effect; Prince of Wales's Pavilion, Swan lamps; Water Pavilion, glow lights by Gooldon and Trotter; South Galleries Middle Court, Swan lamps, 1,080 in number, equalling 1,600 candles, by Mesers. Siemens; North Court, Victoria incandescent lamps, by the Anglo-American Brush Electric Light Corporation; South Court, lights by the Edison-Swan Company; Grill Room, lights by Clark and Chapman; Aquarium, glow lamps by the Gulcher Company; East Gallery, arc lights, by Thompson, Houston, and Co.; South Central Gallery, Jablochkoff arc lights; in different parts of the Exhibition, Pilsen lights, lamps by Paterson and Cooper; Cordner, Allen, and Co.; Clark, Muirhead, and Co. (Carden and Werner patterns); Sennett lamps, and lights by Clark and Bowman. There are also six Hochhausen lamps of 3,000 candle-power each, for the masthead; 12 Siemens lamps of the same strength for the fountains, and 16 Andrewes lights of 800 candle-power for the electric light shed. The steam-power which is to keep in motion the generators will again, as already announced by us, be provided by Messrs. Davey, Paxman, and Co., of Colchester. To the ten steam boilers and five powerful steam engines in use for the lighting of the Health Exhibition they will add eight large locomotive boilers. These new boilers, which are all made of steel of the first quality, are constructed with the most modern improvements. Each will contain 610 square feet of heating surface, and it is computed that, with easy firing, these eight boilers will evaporate 36,000lb. of water into steam per hour. With the whole set of eighteen boilers it is calculated that 110,000lb. of water per hour can be made into steam of 100lb. pressure per square inch. For the illumination of the grounds Messrs. Siemens will employ three engines, capable of about 1,000 horse-power work, by Messrs. Goodfellow and Matthews, of Manchester, supplied by Babcock and Wilcock boilers.

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THEORY OF MAGNETO AND DYNAMO MACHINES.

XXVII.

It may be asked how it happens that this short-circuiting and reversing treatment applied to a coil conveying a powerful current is not attended with more vigorous sparks than are actually observed; but it is to be observed that both operations are of the nature of a *make*—at any rate, there is no true break of circuit. It is just the same operation as putting in and pulling out the plug P in the annexed diagram, except that, to be quite accurate, the battery connections should be supposed reversed every time.

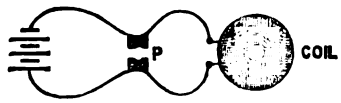

FIG. 1.

A better representation of the action can be given, much as Ayrton and Perry gave it in their article on electro-motors already referred to, viz., this

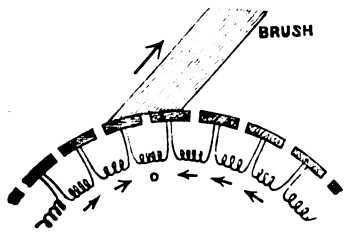

FIG. 2.

Commutator segments with brush resting on them. The coils connecting the segments are diagrammatically indicated, and the direction of the currents in them is shown by arrows. One of the coils is short-circuited by the brush, and the current will immediately be started in it in the reverse direction as the brush passes on.

where P is the brush contact (an Edison sort of brush it is) broad enough to more than bridge the gaps between the successive brass blocks of the commutator, and where the coils connecting the blocks are also very diagrammatically represented. Evidently as the brush moves on, it successively short-circuits each of the coils, and then reverses its current.

The preceding account of the action is in no way affected by the number of coils which the breadth of the brush contact enables it to short-circuit at once, for every coil still undergoes the operation, and undergoes it only once; but there is just this to be considered—viz., that the time of short-circuiting may be so short that the original current has no time to die out before reversal sets in, or it may be so long that the original current has time to die out completely; and in the latter case there is the further consideration as to whether, during the short-circuiting, any lines of force are being cut by the short-circuited coil or not.

The natural position for the short-circuiting to occur is in the line or plane of reversals; that is, where each coil is cutting no lines of force as it moves, or, in other words, where the total number of lines of force produced by the magnetisation of the armature as well as by that of the field magnet passing through the coil is a maximum. As far as external or impressed E.M.F. is concerned this is where the reversal of current should take place; and there it would take place if there were no internal or self-generated E.M.F. tending to prolong the current and delay its reversal. But there always is a self-generated E.M.F. or self-induction in any coil; it is greater if there is iron inside, but it is not *dependent* on the presence of iron by any means. Hence reversal of E.M.F. does not occur the instant a coil reaches the maximum line of force position, but it occurs at some angle ϕ in advance of this. This angle ϕ is what I have called the "lag." In this position some lines of force *are* being cut, but the impressed and self-generated E.M.F's are equal and opposite, consequently there is no current in the coil, except what may be driven through it by other coils.

Now, if there were no lag—that is, if ϕ were nothing—the brush might be set just in the maximum line of force position, the coils as they passed it would be cutting no lines of force, and the brush contact might be fairly broad. In the single coil machine there was an obvious advantage in paying attention to ϕ and setting the brush exactly at this angle in advance of the maximum line of force position, because then there was no current in the coil as the brush crossed the gap, and consequently no sparking or loss of energy, unless the brush were too broad and short-circuited the coil too long; and it ought not to be broad, for in the true ϕ position lines of force are being cut, proportional in fact to sin ϕ, and hence the short-circuiting angle ought to be infinitesimal. But in complex machines, where every coil has a current driven through it by its neighbours whether it is helping it itself or not, the advantage of paying exact attention to ϕ is not so manifest. The position of reversal is not one of zero E.M.F., as in a single coil, but of maximum E.M.F.; viz., just that position where the coil about to be short-circuited can contribute nothing to the E.M.F. Hence it might appear that the last dregs of help are obtained from every coil by setting the brushes at the angle ϕ in advance of the maximum line of force position; whereas, by neglecting this, some useful E.M.F. is wasted, and that this is the advantage of attending to ϕ. But then remember that the E.M.F. in a single coil after it has passed the maximum line of force position, *i.e.*, while turning through the angle ϕ, is entirely self-generated, and is due to the dying out of its own current. The diminishing current excites by self-induction an E.M.F. tending to prolong its life. Now, in a multiple coil machine the current in any one coil is not allowed to die out, but is kept fairly constant by the other coils; hence the self-induction has no opportunity of displaying itself, and as soon as a coil has passed its maximum line of force position it ceases to aid the current, and is best short-circuited out.

If this be correct, it follows that a fairly broad brush contact beginning at or near the true neutral plane is better than a narrow brush contact at an angle ϕ in advance; and much better than a broad brush contact at the latter place, because this would cause lines of force to be cut by short-circuited coils.

One advantage of a fairly broad contact is that it diminishes the resistance of the armature, not simply by increasing the area of contact, which a *wide* brush would equally well do, but by always short-circuiting out of the main circuit those few coils of the armature which at any instant are not helping the current on much, and whose resistance is therefore better got rid of. At the same time the number of such comparatively idle coils in a good machine ought to be very small. In a uniform field they would decidedly exist; but the object of curving the pole pieces well round the armature is to press every coil into active service as far as may be.

Besides the obvious gain in setting the middle of the brushes at the points of maximum and minimum potential respectively, there is also the advantage that the potential with which each segment of the commutator reaches a brush is the same as that with which it leaves it, and thus fluctuations of the current and sparks from this cause are avoided, as is fully pointed out in Article XX.

In a single coil machine each brush had to touch the middle of a commutator segment when the E.M.F. in the coil was a maximum, and it was to rest across the gap when the E.M.F. was zero. In the multiple coil machine the position of the brushes should be that of maximum E.M.F.

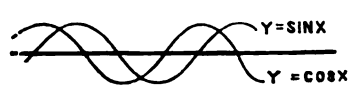

FIG. 3.

Of the two curves, each has its maximum where the other has its zero; illustrating the fact that at the position where the maximum E.M.F. can be tapped off an armature commutator, there each individual coil of the armature has no E.M.F. in it, and contributes nothing to the sum or total E.M.F.

always. The short-circuiting of each coil in the maximum position in the latter case, can be easily seen to agree exactly with the short-circuiting in the zero position in the [illegible] if

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it be considered that the E.M.F. of all the separate coils in a multiple machine are added together, and that the result reaches a maximum just in the place where each coil adds nothing to the effect, *i.e.*, where it has zero E.M.F. in it. It is just the difference between the curves cos x and sin x, the latter being the integral of the former, and having its maximum when the other has its zero. See the formulæ in Article XX., where the E.M.F. of each separate coil was proportional to the *sine* of an angle: the total E.M.F. in all the coils was proportional to its *cosine*.

ALTERNATING CURRENTS.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 374.)

[*Erratum.*—P. 373, col. ii., lines 22-3-4 should be read:—$\frac{OE'}{r}$ and $\frac{E'F'}{r}$ are those currents considered as conveying electricity *into* the condenser, the positive current in R being of course a negative current as regards charging the condenser.]

We may easily extend the reasoning of the case when the circuit is bridged by one condenser to that in which at several points condensers are situated, as indicated by Fig. 8.

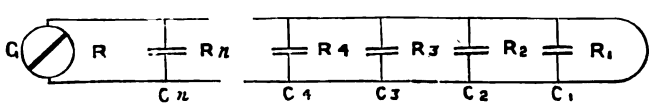

FIG. 8.

In this figure G is a generator, and the circuit is bridged at various points C_1 C_2, &c., by condensers of capacity C_1 C_2, &c. R_1 is the resistance of the remotest section, R_2 that of the section between condensers C_1 and C_2, R_3 that of the section between condensers C_2 and C_3, and so on, up to C_n, where the last condenser is situated. R is the resistance of that section which contains the generator. Suppose, also, that there is no self-induction in any of the sections.

So far as the two remotest sections are concerned, the distribution of flow will follow that of the case already given, when the potential difference of the plates of the condenser C_2 takes the place of the impressed E.M.F. Suppose, therefore, E_1 C (Fig. 9) to be the potential difference of the plates of

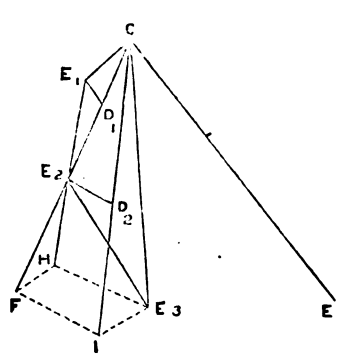

FIG. 9

condenser C_1, which for brevity we will call the E.M.F. of condenser C_1,

Set off the angle $E_1 C D_1$ in the direction of advancement so that its tangent is equal to $\frac{C_1 \pi R_1 R_2}{T(R_1+R_2)}$. Draw $E_1 D_1$ perpendicular to E' C, cutting C D_1 in D_1, and produce C D_1 to E_2, so that $C D_1 : D_1 E_2 :: R_1 : R_2$. Join $E_1 E_2$. Then E_2 C is the impressed E.M.F., so far as the two remotest sections are concerned. Therefore, E_2 C is the E M.F. of condenser C_2, and $\frac{E_2 E_1}{R_2}$ is the current in R_2.

Now, set off the angle $E_2 C D_2$ in the direction of advancement such that its tangent is equal to $\frac{C_2 \pi R_2 R_3}{T(R_2+R_3)}$, and draw $E_2 D_2$ perpendicular to C E_2. Produce C D_2 to L, so that $C D_2 : D_2 L :: R_2 : R_3$, and draw L F parallel to $D_2 E_2$ to cut C E_2 produced in F.

Produce $E_1 E_2$ to H, so that $E_1 E_2 : E_2 H :: R_2 : R_3$. Join F H, and draw H E_3 parallel to and equal to F L. Join C E_3, E_3, E_2. Then, E_3 C is the E.M.F. of condenser C_3, and $\frac{E_3 E_2}{R_3}$ is the current in R_3.

These points are proved by the following considerations:—

Firstly, $\frac{L F}{R_3}$ is the effective charging current for the condenser C_2, because $\frac{L F}{F C} = \tan F C L = \frac{C_2 \pi R_2 R_3}{T(R_2+R_3)}$ by construction, and $\frac{F C}{E_2 C} = \frac{\overline{R_2+R_3}}{R_2}$.

Therefore, $\frac{L F}{E_2 C} = \frac{C_2 \pi R_3}{T}$, or $\frac{L F}{R_3} \frac{T}{\pi} \frac{1}{C_2} = E_2 C$.

Therefore, by the formula given at the top of p. 327, col. ii., $\frac{L F}{R_3}$ is the effective current charging the condenser C_2, and L F being at right angles to C E_2, is in its right phase.

But E_3 H is equal and parallel to L F; therefore, $\frac{E_3 H}{R_3}$ is the effective charging current for the condenser C_2.

Secondly, one actual current affecting the condenser C_2 is $\frac{E_2 E_1}{R_2}$, which flows away from the condenser through the section R_2.

Considered as an accumulating current it is $\frac{E_1 E_2}{R_2}$; but $E_2 H : E_1 E_2 :: R_3 : R_2$. Therefore, $\frac{E_2 H}{R_3} = \frac{E_1 E_2}{R_2}$.

Thus $\frac{E_2 H}{R_3}$ is one of the currents composing the effective charging current $\frac{E_3 H}{R_3}$. Therefore, $\frac{E_3 E_2}{R_3}$ is the other component. That is to say, that $E_3 E_2$ is the effective E.M.F. in the circuit R_3.

This again being the resultant of the combined simultaneous action upon the resistance R_3 of the E.M. forces of the two condensers C_2 and C_3, and E_2 C being that of the condenser C_2, it follows that E_3 C is the E.M.F. of the condenser C_3.

It is clear that by extending the construction in the same way until we have taken all the sections into consideration, we shall ultimately arrive at one line, C E, which will represent the E.M.F. of the machine necessary to generate the currents indicated.

It would be very hard to construct a figure from the final line C E; but this process is unnecessary, because the actual value of the impressed E.M.F. would only affect the scale upon which the various lines should be measured, but not the angles or relative sizes of the lines in the diagram. A proper scale being therefore furnished from the final line to represent the value of the E.M.F. of the generator, it may be applied at once to the diagram to indicate—(1) the effective E.M.F. in each section as given by such lines as E_3 E_2, E_2 E E_1, which being divided by the resistance in the particular section will give the current—(2) the difference of potential of the plates of the various condensers as given by C E_2, C E_3, &c.

From the diagram it is clear that the general effect of condensers placed locally as bridges in a circuit is twofold. In the first place, when the sections of the circuit are considered in order, there is a continual delay in phase as we recede from the generator. In the second place, the current in the nearer sections is increased, and in the remoter sections diminished by the introduction of the condensers.

If in such a circuit there were a number of incandescent lamps in series, the effect of joining up with the condensers

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would be that the lamps nearer the generator would shine more brightly, and those most remote would become duller, while there might be some in the intermediate sections which would indicate no change.

These observations serve to indicate the nature and reason of the delay in an alternating current in a long cable possessing capacity, which will be dealt with more minutely later on. They also explain the error in estimating an electric current by dividing the electromotive force by the resistance, when that electromotive force is a rapidly variable one, and there happens to be any great capacity for electricity involved in the system. It has been already indicated that a voltameter possesses capacity, and there is strong reason to believe that the tissues of the human body possess considerable capacity, probably in the same way as a voltameter possesses it.

If two Geissler tubes are placed in series in the secondary circuit of a Ruhmkorff apparatus, and the pole of a condenser is connected with their point of junction, then either tube may have the intensity of its light increased by the junction of the other pole of the condenser with that electrode of the secondary coil to which the other tube is attached. That other tube suffers a diminution or extinction of its light at the same time. It is in what has been called the remote section. A precisely similar effect is the result of using the two hands as the poles of the condenser. Of course this experiment lies open to the suggestion that it is the conductivity of the body which, when inserted in the system in the above manner, would relieve the remote section, and throw more current through the near one, that produces the effect observed. But there are numerous other facts pointing to the same conclusion, which can moreover be directly tested by suitable instruments.

(TO BE CONTINUED.)

MULTIPLE MAIN SYSTEMS.

BY W. H. SNELL, A.S.T.E. AND E.

A writer in an American scientific journal has recently developed some considerations relating to "multiple mains," from which he obtains "the most economical plan" of laying out any such system of conductors. But it is not very difficult to show that a still more economical plan is *possible*; and not only possible, but (so I venture to think) likely to be of some practical importance.

Let us compare a system of n conductors supplying a certain number of lamps with a system in which the same number of lamps is supplied by two conductors only.

In the latter case let C be the current, and let W be the economical weight per unit length for each conductor. Then, as an expression for the most economical current in terms of W, we can put

$$C = W\sqrt{\frac{k_2}{k_1}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

k_1 being a constant depending upon the cost of energy and k_2 a constant depending upon the annual charge for the cable.

Now, in a system of multiple mains (except towards the farthest extremity of any given branch) the current flowing anywhere in the intermediate wires, will be negligible in comparison with the current in the two external conductors. This is more especially true because we are concerned only with the heating effect of the current, which varies with its square. If, then, we neglect the heat wasted in the intermediate wires, we shall have, for the total cost of the energy expended in the mains, the expression

$$\frac{2C_n^2}{W_n}k_1$$

and for the annual charge upon the cables, we have

$$n\,W_n\,k_2$$

For the minimum value of W_n this gives

$$W_n = C_n\sqrt{\frac{2k_1}{n\,k_2}} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

But $C_n = \frac{C}{n-1}$, or inserting the value of C from (1)

$$C_n = \frac{W}{n-1}\sqrt{\frac{k_2}{k_1}}.$$

Therefore (2) becomes

$$W_n = \frac{W}{n-1}\sqrt{\frac{2}{n}} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Up to this point we have substantially followed our American friend, and it is from a formula similar to the above that his "most economical" results are obtained. But if the current in the intermediate conductors at all approaches a negligible value, why need we make these wires of equal size with the outer pair? Of course the suggestion to use smaller intermediate wires is nothing new. If I remember rightly, such a proposal was originally made by Dr. Hopkinson, the inventor of the system; and Professor Forbes has recently expressed himself in favour of the plan—up to a certain point, of course.

But when this is combined with the other conditions of economy, such an arrangement possesses advantages which I think have not yet been mentioned.

Suppose that we make the weight per unit length of the intermediate conductors p times that of the external pair—p being some fraction. Then the expression for the annual charge upon the cables takes the form

$$W_n k_2 \{2 + p(n-2)\}$$

and therefore (3) becomes

$$W_n = \frac{W}{n-1}\sqrt{\left\{\frac{2}{2+p(n-2)}\right\}} \quad . \quad . \quad (4)$$

In the following table, which is derived from this formula, W_n indicates the weight per unit length for each of the external conductors, W_i the same for the intermediate conductors, and W_t is the total weight for n mains. Only three values of n are given; the higher values can hardly be considered to have any practical importance. Four values of p are taken; $p=1$, $p=0{\cdot}75$, $p=0{\cdot}5$, $p=0{\cdot}33$.

	n	p	W_n	W_i	W_t	Per cent of W_t
(1)	2	0	1·000	—	2·000	100
(2)	3	1·00	·408	·408	1·224	61·2
(3)	3	0·75	·425	·318	1·169	58·5
(4)	3	0·50	·447	·223	1·117	55·8
(5)	3	0·33	·462	·154	1·078	53·9
(6)	4	1·00	·236	·236	0·944	47·2
(7)	4	0·75	·251	·188	0·878	43·9
(8)	4	0·50	·272	·136	0·816	40·8
(9)	4	0·33	·288	·096	0·768	38·4

It will be seen that when p is less than unity we obtain a double advantage, for while the *total* weight is decreased, yet W_n, the weight of the working conductors, has been increased. So far this shows a saving over the results obtained from formula (3), varying from about 4½ per cent. up to nearly 19 per cent. upon the first cost, and "by construction" a *proportionate* saving in working expenses.

But this is not all. By thus diminishing the relative dimensions of the intermediate wires while maintaining the economical relation between current and resistance, at the same time we increase the limiting distance between any lamp and the nearest point of constant potential.

If L be this limiting distance in the case when $n=2$, then it may be shown that for any other value of n we shall have

$$L_n = L(n-1)\sqrt{\left\{\frac{2}{2+p(n-2)}\right\}} \quad . \quad . \quad . \quad (5)$$

or, when $p=1$

$$L_n = L(n-1)\sqrt{\frac{2}{n}} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

From this formula (5) the results in the annexed table are obtained. They are numbered for comparison with the former table.

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	n	p	L
(1)	2	0	1·00
(2)	3	1·00	1·62
(3)	3	0·75	1·70
(4)	3	0·50	1·79
(5)	3	0·33	1·85
(6)	4	1·00	2·12
(7)	4	0·75	2·26
(8)	4	0·50	2·45
(9)	4	0·33	2·60

No. 4 seems to be a very practical arrrangement; compared with No. 2 (where $p = 1$), it will be seen that we effect an economy of metal amounting to nearly 9 per cent, a certain economy of working expense, and at the same time the extreme distance which can be supplied from any one point of distribution is extended by about 10 per cent. Or compared with the double conductor system, we obtain an economy of about 44 per cent. in the weight of metal, and we increase the working distance by nearly 80 per cent.

The value of p ought perhaps to be determined by considerations as to the amount of current which the intermediate conductor might in an extreme case be called upon to transmit. But this should have reference solely to its capacity to convey such a current without overheating—the question of economy does not come in. Other things being equal, it appears to me that it is best to take p as small as possible in the larger mains, and to allow its value gradually to increase towards the extremities of each district.

THE INTERNATIONAL SOCIETY OF ELECTRICIANS.

(FROM OUR SPECIAL CORRESPONDENT.)

PARIS, March 25.

The Exhibition and Conference of the International Society of Electricians, now being held at the Observatory at Paris, was formally opened last Saturday. Special tickets were issued for the formal opening, and it was not till the next day that the ordinary tickets were of avail. It would be useless to attempt to lead any of our readers to expect that in the following description of this Exhibition he will find anything that is very new. Like all displays of its kind it has, however, caught the popular taste, and evening after evening the rooms devoted to the exhibition of apparatus are crowded with sight-seers. These rooms are more than well lighted by means of electricity, although in some cases the lights will not bear the test of careful examination, in that they have been—especially the arc lamps—rather hurriedly put up and flicker. It may be a token of supreme ignorance of all that concerns electrical societies when it is said that we have been unable to find the reasons which have led to this Exhibition. One friend was good enough to say that an analogy—only that it lasted but for one night—was to be found in the *conversazione* usually held once a year by the Society of Telegraph-Engineers. It is customary to exhibit a few instruments at such *conversazione*, and to in some way or other obtain a pleasant place of meeting. This *conversazione*, if it may be so called, extends over a week, and, in addition to the Exhibition, each evening there are one or two more or less popular lectures. From a scientific point of view we have nothing to say about these lectures, the visitors to the Exhibition crowd into the lecture room to overflowing, but it was conspicuously noticed that many whom it would have been thought would have been supporting the lecturer did not enter the lecture room. We fear that the life and work of the International Society, unless a considerable alteration takes place in its organisation, are destined to be short. What has an International Society of Electricians to do with a popular display? Such displays are mere advertisements, very good in their way—in fact, excellently so; but the work of such a society as this claims to be should be of a somewhat higher character than that we have described.

The steam-power used in driving the dynamos and the dynamos themselves are placed in a temporary building, which is to the right of the main entrance to the Observatory, and the leading wires of the various dynamos are carried to the points from whence the currents are taken. The dynamos are principally of the Siemens, Mcritens, Jablochkoff, and Gramme type. It was owing to the backward state of this machine room that the opening of the Exhibition was delayed for a week, and this delay, we believe, kept a good many English electricians from the Exhibition. The horse-power employed is obtained from six or seven steam engines, one of 60 horse-power, by Messrs. Chaligney and Co., which firm also supply a portable engine of 15 horse-power. The Société l'Eclairage Electrique has engines of 20 horse-power. Messrs. Triponé and Sons will have ready towards the end of the Exhibition a fast-speed engine, while Messrs. Weyher and Richemond have two engines respectively of 25 and 35 horse-power.

The yard inside the gates is lighted by means of Jablochkoff lamps, while from the summit of the Observatory are two projectors, and in various parts of the building are to be found arc lamps of the Siemens type and of the Cance, while the principal display of incandescent lamps is that of Gerard, who claims to exhibit a very economical lamp, of which more hereafter. Edison and Swan lamps are also exhibited in several rooms, and on the whole the incandescent lighting is very good, while, as we have said, the arc light is subject to annoying fluctuations. It is impossible to find anything new to say about the arc lights, or much that is new about the incandescent lights. With regard to the claim of the Gerard Company that their lamps are very economical, a 50-light lamp requiring 75 watts and being a low resistance lamp—that is, requiring E.M.F. of 30 volts, and taking a current of $2\frac{1}{2}$—there is still one fact wanting, namely, the life of the lamp. It will be seen that this claim is a candle per $1\frac{1}{2}$ watts, which after all is not a singular claim. The lamp shown by M. Aboilard, for example, gives, according to the exhibitor, a similar output.

Leaving for the present the electric lighting and coming to the ordinary exhibits, we notice that the only English house which can be said to be represented is that of Messrs. Elliot Bros.; their agent, Mr. Aylmer, exhibits a good selection of their instruments. The exhibit includes Thomson's galvanometers, condensers, resistance boxes, various ammeters and other of their well known instruments. Close to this exhibit is that of M. Menier, who is the only exhibitor of cables. Close by is the exhibit of Messrs. Maiche and Co., where will be found the micrometer for measuring very small resistances. This has already been alluded to in previous issues, and we intend to illustrate it. There is no doubt the instrument will be found very useful in many factories where the measurement of small resistances is a necessity. Another instrument which has attracted some attention is the modified Morse instrument of M. Estienne. The receiving position of this instrument prints the Morse symbols vertically instead of horizontally. Our readers will recollect that this has already been done in England by Mr. Herring. M. Estienne claims that his instrument is more simple than that of Mr. Herring, otherwise the advantages put forward for the use of such an instrument, such as the clearness of impression, the saving of the paper, and the impossibility of making any error between the dot and the dash are just those claims which are put forward by previous inventors. Messrs. Radiquet and Sons show a bichromate battery, for which they claim certain advantages. The porous jar forms on side of a W-shaped tube; when not in use this tube is thrown over by means of a hinge, and the liquid in the porous jar runs into the other arm, leaving the zinc out of contact with the liquid, and in throwing over the porous jar itself is also brought out of contact with the liquid in the other part of the cell. Thus, when not in use, the zinc is not in contact with the acidulated water, and the two liquids are isolated from each other.

(TO BE CONTINUED.)

PRIMERS OF ELECTRICITY.—These Primers (by Prof. Houston and others), which had a large sale at the recent Philadelphia Exhibition, can now be obtained at the office of *The Electrician*, price 1s. the set of twenty-seven.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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GOOD FRIDAY.—Next week "The Electrician" will be published on Thursday instead of on Friday.

LETTERS.

A letter awaits S. J.

OVERHEAD WIRES.—A NEW REMEDY.

It has often been a matter of surprise to us that the inhabitants of London have so long endured without active protest, though not without manifest impatience, the encroachments on private property, the violations of public decency, and the imperilling of public safety of which the telephone companies have been shamelessly and increasingly guilty during the past three or four years. That everybody's business is nobody's business seems peculiarly true of overhead telephone wires. At all events, whilst several parish authorities have been protesting in a half-hearted, disunited, and ineffectual way, it has been reserved for a private firm to take the first step which really promises some hope of an abatement of this crying evil.

According to the story told in the correspondence just published by Messrs. J. Travers and Sons, of 119, Cannon-street, London,—and we have no reason to suppose that their case is a peculiarly exceptional one,—the telephone companies have managed matters so that their own customers are beginning to revolt against the arbitrary and high-handed indignities to which they are subjected at the hands of the purveyors of public telephony. The firm just mentioned is not the first to have protested, but they appear to be the first to have gone the length of protesting with a purpose and determination to clear the company, their emissaries, and their fixtures off the premises, appealing to the public and to the Postmaster-General to come to the firm's assistance.

This is the interesting story as told by Messrs. Travers and Co. In March, 1880, they entered into an agreement with the United Telephone Company to supply the use of a telephone connected with their Exchange on the usual terms. Very soon the company discovered that the roof of Messrs. Travers' wholesale warehouse offered splendid facilities for erecting an almost unlimited number of additional poles, wires, and appliances; and that theirs was a convenient route for wires to take on the way to more distant regions. In spite of the continual complaints of Messrs. Travers, and the warnings of the ground landlords, the company's servants invaded the premises at their own sweet will, and erected a network of wires over the roof and glass skylight, sometimes doing actual damage, always jeopardising the safety of the customers below, and in the opinion of legal advisers were rapidly establishing a right of user which, if not resisted soon, might be difficult to upset.

The company took next to no notice of these complaints, but at length deemed it advisable, not for this case alone we may be sure, to alter the terms of their agreement with their customers as the old agreements fell through. Consequently in January last it was intimated to the refractory wholesale grocers and wine merchants of Cannon-street that a quite new form of agreement would have to be signed by them, or their use of the telephone would cease in the present month of March. The new agreement contained two clauses in particular which the Renter objected to. One clause requires him to give access to the company's agents, workmen, &c., at all times to the premises; and another clause covenants that the Renter shall give every facility "in the way of poles, attachments, &c., to the company for running his own wire"—a quite superfluous covenant we should think—but "*also those of other subscribers to the company's system whether exchange or private*"—a covenant which virtually compels a Renter not only to pay his subscription for the use of the telephone, but to provide free of cost and at his own risk wayleave and fixation for as many poles and wires as the company may please to establish on his premises. This, together with the right of way for the workmen "at all times," constitutes, we need hardly say, a virtual surrender of proprietorship, and, when the tenant is not the freeholder, as in the case of Messrs. Travers, a dangerous encroachment on the rights of the superior landlord.

On one occasion before matters came to this pass the renters, seeing the legal risks they were incurring, had threatened the company with legal proceedings if they did not remove all wires except the Renters' own. On this the company playfully retaliated by "severing our connection with the exchange"—we use Messrs. Travers' own words—"under pretence of altering our own wire, and kept us for three months without the use of our telephone, although we had paid you rent for that time, and there was no reason for not restoring the communication." Thus it would appear that when a customer shows signs of restiveness the company bring him to his senses, as grooms do rebellious horses, by reducing his provender. Failing this the brutes—we beg Messrs. Travers' pardon—are reduced by starvation. Trusting to these effectual methods the secretary of the United Telephone Company, Mr. Thomas Blaikie, wrote to 119, Cannon-street on January 29th, insidiously remarking, "We feel sure that on reflection you will see the reasonableness of the terms insisted on."

But here Mr. Blaikie's perceptions failed him. By that letter he not only lost Messrs. Travers as customers, but also the splendid roof and convenient resting place for a magnifi-

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cent display of wirework in "a direct line between an Exchange and some of the most crowded parts of the City." Worse than this, the Postmaster-General is appealed to; and he has undertaken, if the rebellious grocers will find fifty subscribers, that an exchange system will be established by the Post Office at a rental something less than that which is paid to the United Telephone Company. As we gather from the terms of the Post Office Secretary's letter that the wires will be laid underground, it would appear that an underground system can be had by the public at the hands of the Post Office without any additional charge, and without any of the dangers and petty tyrannies of which the private company has been guilty, even though the guaranteed number of subscribers are to be counted by units when the company with its overhead system counts them by thousands.

This it seems to us is a conclusive answer to the oft-repeated assertion that the underground system is enormously costly. Some very misleading evidence on this point was tendered to the parliamentary committee on overhead wires at its sitting on Monday. It may be literally true that to erect a single wire overhead will cost thirty times less than to put it underground. But it is time this statement, which is only a partial truth, was explained away. Wire for wire the cost of the underground wires is not nearly so great, and the cost of laying them is mainly for the tubing; and when, as they always ought to be, they are submerged in large quantities, the comparative cost is reduced in proportion to the number of wires laid down. In other words, roughly speaking, while every additional wire erected overhead involves an equally additional expense, the cost of laying them underground is no greater for fifty wires than for one.

The object of Messrs. Travers in publishing this interesting correspondence is no doubt to obtain a sufficient number of subscribers to justify the Post Office in taking the matter into their own hands. We have always deprecated active competition between the Post Office and the companies; but we have always predicted that the time for it would sooner or later arrive, and we think this is the time for a Departmental interference. We hope that Messrs. Travers may succeed in their public appeal; but be this as it may we do not see how the Post Office can refuse to come to the rescue in a case like this. We agree that the Post Office, which derives a revenue from the granting of licences to these companies, "is the guardian of public rights" in this matter, and that in granting a special monopoly it is bound to see that the powers exercised under it are not abused to the injury of private property or the endangering of public safety.

CORRESPONDENCE.

THE BROOKS UNDERGROUND CIRCUIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of February 21st, 1885, there is a description of the Brooks Underground Conduit, as exhibited at the late Electrical Exhibition in Philadelphia. So much of this notice as is copied from the examiners' report I desire to friendly criticise. "A number of experiments were made as to the effect of the Brooks system in reducing induction and other disturbing elements. One of these was a line through a Brooks conduit to the Broad-street station and a return through the earth." No wires whatever were worked to the Broad-street station. "A second circuit was metallic, *i.e.*, the message went and returned by wire, the distance between the station being about one and-a-quarter mile; the crackling noise was audible, but not loud or deep." We worked a metallic circuit to the Kensington station, seven miles, and also a single circuit the same distance, and endeavoured to show the difference between the metallic circuit and the single circuit. Remember the distance between the Exhibition and Kensington by the route of the wires is seven miles. "A line to Merion station and return by overhead wire, fourteen miles, worked nearly as well." As Merion station is only four and three-quarter miles distant, there is a very considerable error as regards distance, but a more serious error is the fact that there was nothing of the kind working to Merion station from the Exhibition. "No means were available for testing the amount of interference with each other of the several wires of telegraphic and telephonic circuits in the same tube, worked simultaneously." As the wires of the Pennsylvania R. R. Company for telephone and telegraph purposes, and three conductors of the Western Union Telegraph Company, operated by dynamos of high potential, were working it through the same tube during every hour of the Exhibition, all inductive disturbance came from those sources; and yet they say no means were afforded for observing the effect.—Yours, &c.,

H. C. FREMPT, Superintendent Brooks's Underground Conduit Company, Philadelphia.

THE TELEPHONE IN PARIS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: *The Electrician* of the 24th January arrived this morning, and I beg to call your attention to the astonishing small number of physicians and lawyers who, as per your statements, are subscribers to the telephone in Paris, against the number of telephone subscribers of the same professions in Buenos Aires, namely:—Six physicians in Paris, against 113 in Buenos Aires; 21 barristers and solicitors in Paris, against 109 in Buenos Aires; notwithstanding the fact that the former town has nearly ten times the number of inhabitants of the latter.

The same number of *The Electrician* contains an article, headed "River Plate Telephone Company," which might convey the idea that the Gower-Bell is preferred here to the Bell-Blake, used by the United Telephone Company of the River Plate.

This is not the case. The number of telephones actually in use on the River Plate (in the Argentine and Uruguay Republics together) can be estimated to be as follows:—

Bell-Blake	3,210
Gower-Bell	2,120
Siemens	600
Breguet	250
Ader	130
Various systems	90
Total	6,400

As those numbers are changing daily, I could not guarantee their absolute correctness, but consider them to be a very fair estimate.—Yours, &c., AD. FELS, Director.

Buenos Aires, 26th February, 1885.

THE ELECTRIC TRAMWAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I saw Mr. Holroyd Smith's system in action at Manchester. The arrangement for conveying the current to the tram certainly seemed very perfect; but in the case of continued heavy rain the water would be likely to partly or wholly fill up the channel the copper conductor slides in, reducing the resistance of the insulation considerably.

Would it not be better if this channel were in connection with the street drains at different parts of the route?—Yours, &c., W. S. H.

ORGAN-PLAYING BY ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I should feel very much obliged if you or some of your readers would kindly give me a description of the devices for playing organs by electricity (command of stops, &c.), as frequently used in America for big instruments.—Yours, &c.,

FREDERICK DREXLER.

Vienna, IV. Mittersteig 17.

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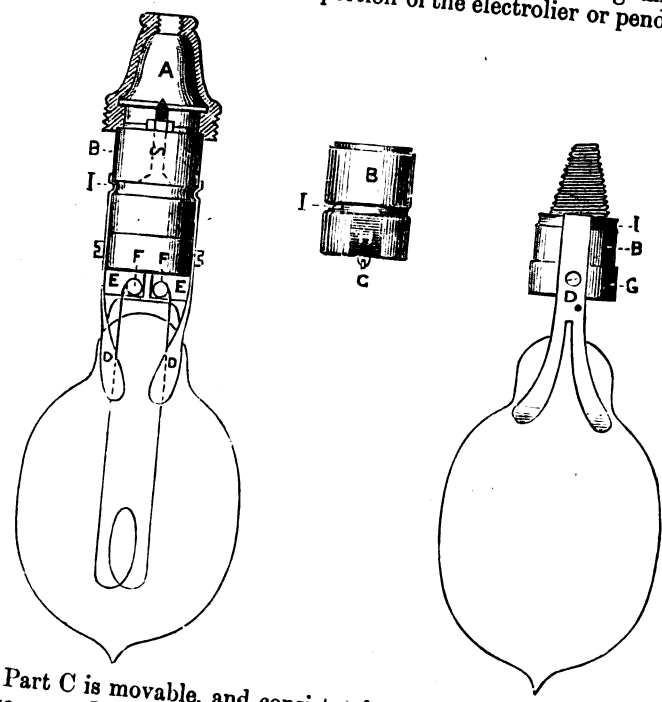
GRUNDY'S LAMP-HOLDER.

Fig. 1 is the lamp-holder as fitted at the Royal Courts of Justice. Fig. 3 is the same adapted to screw into an ordinary gas or other tube. Fig. 2 is the upper part of the holder, showing the electrical connections, which are identical in both cases. The insulating parts are different, inasmuch as the upper part of Fig. 1 is fixed to its socket by a screw through its centre, and has two holes for the leading wires, while Fig. 3 has to be screwed into the tube, and has only one hole through the centre for the two leads to prevent them being twisted in the operation.

A is the gun metal nozzle which is in use in the fittings at the Law Courts, for which these holders were originally designed. This nozzle terminates the pendant, tubular or flexible. If flexible the space of the tube is occupied by a plug of vulcanite or other insulator with two holes through it for the wires. The leads pass through two holes in part B, and are secured by the binding screws G in part B1, thus ensuring a good contact between the leads and the parts H, which extend up the sides of B as far af the groove I. S is the screw which secures B to A. The plates H, one on either side of B, now represent + and − of the circuit; and this part being unconnected is to remain a fixed portion of the electrolier or pendant.



Part C is movable, and consists of an insulating block, with two arms, D D, spread out in a fan-shape at one end, so as to partially encircle the neck of the lamp, and terminating at the other extemity in a shoulder made to fit the groove I in Part B. The lamp is connected by its legs to the arms D D by means of the split blocks E E being pinched between the two parts, then by the screws F F. A good contact is thus secured, as well as great rigidity in the lamp.

The parts of the arms D D which make contact with H H are about ½in. square, and the fact of their being so easily accessible, and their rubbing motion in switching off and on, ensures them being kept clean and bright.

As the lamp can at any leisure moment be fitted to the part C, and a few spare parts can be kept, the lamps can if necessary be replaced in a second, without any danger of fusing the lugs or lamp hooks, as is often the case in putting up a lamp with the current on. It is claimed for these holders that they are simpler and more reliable than any at present in the market. The construction of the holder and the security of its connections are such as to make it practically everlasting.

It can also be used as a switch whenever the lamp is within reach, and from the fact of both + and − being broken at the same moment no sparking is likely to take place. When required for this purpose a stop is provided to prevent overturning.

ON THE CHARACTERISTIC CURVES AND SURFACES OF INCANDESCENT LAMPS.*

BY J. A. FLEMING, M.A., D.SC. LOND., FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE.

(CONCLUDED FROM PAGE 402.)

An attempt was made in the next place to endeavour to obtain an approximate empirical formula, connecting the efficiency of a lamp or the candles per horse-power and the electromotive force. On April 15, 1882, Professor A. Jamieson read a paper before the Society of Telegraphic Engineers and of Electricians (*Journal Soc. Tel. Eng.*, Vol. XI., p. 164), "On Tests of Incandescent Lamps," and he has there given a number of tables and curves for different lamps, giving the efficiencies and resistances for various electromotive forces.

These observations afford a convenient means of putting to the test empirical formulæ, because the observations seem to have been carried out with very great care, and being done with secondary and primary batteries as current generators. The observations are more likely to be accurate than when current from a dynamo machine is used; also because the observations for candle-power were entrusted to Dr. Wallace, gas analyst for Glasgow, and were therefore in the hands of an observer whose eye was probably more trained to detect minute differences of illumination than one not so familiar with such work.

Professor Jamieson gives one complete table of the constants of an Edison 8-candle lamp over a great range of candle-power. Selecting that portion of the table in which the electromotive force was high enough to illuminate the lamp, we have as follows:—

Tests of an Edison 8-candle Lamp, made by Professor Jamieson, March 8, 1882.

Resistance R.	E.M.F. in volts V.	Current in amperes A.	Candle-power K.
63·7	45·9	·722	5·2
63·3	46·7	·737	6·2
62·7	48·3	·77	8·2
61	51·9	·85	12·9
60·6	53	·874	14·3
59·3	56·2	·948	21·3
58·4	58	·995	25·3
57·8	61·1	1·06	35·8
57	63·1	1·21	43·8

If we take the logarithms of these numbers we have the following table:—

Edison 8-candle Lamp.

log R	log V	log A	log K
1·80414	1·66181	$\bar{1}$·85854	·71600
1·80140	1·66932	$\bar{1}$·86747	·79239
1·79729	1·68395	$\bar{1}$·88649	·91381
1·78533	1·71517	$\bar{1}$·92942	1·11059
1·78247	1·72428	$\bar{1}$·94151	1·15534
1·77305	1·74974	$\bar{1}$·97681	1·32838
1·76641	1·76343	$\bar{1}$·99782	1·40312
1·76193	1·78604	·02531	1·55388
1·75587	1·80003	·08279	1·64147

Let E be the watts of the lamp and R the efficiency or candles per horse-power. Then

$$R = \frac{K\,746}{A\,V},$$

and if we calculate the logarithms of the efficiency corresponding to each electromotive force value, and compare these with four times the value of the corresponding electromotive force, we have the following table:—

log *k*.	4 log *v*.	4 log *v* − log *k*.	
2·06839	6·64724	4·57885	
2·13834	6·67728	4·53894	
2·21611	6·73580	4·51969	
2·33879	6·86068	4·52189	
2·36229	6·89712	4·53483	mean = 4·52968
2·47457	6·99896	4·52439	= log 33860
2·51461	7·05372	4·53911	
2·61527	7·04416	4·52889	
2·63137	7·20012	4·56885	

Excepting the first and last values, which are the result of observations on the candle-power at extreme values, the intermediate figures are not very far from constant, and indicate, as a first rough approximation, that efficiency varies as the fourth power of the electromotive force.

At both high and low candle-powers the comparison of the light with a standard candle is difficult. In one case an excess of red, and in the other an excess of violet rays make the comparison of the naked lights much more difficult at extremes, and, as is well known, the efficiency for very high or low candle-power must be stated for a definite radiation. The only other comparison between these two variables attemped has been in the case of the experiments made by the committee appointed to report on the incandescent lamps in the Paris Electrical Exhibition, an abstract of which appears in the same volume of the *Journal* of the Society of Telegraph-Engineers. The committee condense

* Read at the Physical Society, 14th March, 1885.

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these results on four varieties of lamps into the following numbers for the efficiencies, or candles per horse-power and electromotive force working them, taken at two very different values.

	Edison.		Swan.	
E.M.F.	89·11	98·39	47·3	54·21
Candles per horse-power	196·4	307·2	177·9	262·5
	Lane-Fox.		**Maxim.**	
E.M.F.	43·63	48·22	56·49	62·27
Candles per horse-power	173·6	276·9	151·3	239·4

If we take the logarithm of each number, and compare the difference of the logarithm of the efficiencies with the difference of the logarithm of the corresponding electromotive forces for each lamp, we have the following rates :—

Edison.	Swan.
$\frac{19428}{4302} = 4{\cdot}5$	$\frac{16895}{5922} = 2{\cdot}9$
Lane-Fox.	**Maxim.**
$\frac{20277}{4344} = 4{\cdot}6$	$\frac{19928}{4231} = 4{\cdot}7$

If, therefore, k_1 and k_2 be the efficiencies corresponding to two observed values v_1 and v_2 of electromotive force,

$$\frac{\log k_1 - \log k_2}{\log v_1 - \log v_2} = 4{\cdot}5,$$

or

$$k = C v^{4{\cdot}5}$$

represents an approximate formula for calculating the efficiency. If now approximately in the case of an Edison lamp the candles per horse-power vary, as the 4·5 power of the electromotive force, and the life varies inversely as the 25th power of the electromotive force, it follows that

$$l \propto \frac{1}{k^{5{\cdot}7}}$$

or, roughly that, the life varies inversely as some power between 5 and 6 of the candles per horse-power.

The writer was given in America an extensive series of observation on the relation between the candles per horse-power and the average life, which were as follows :—

Life.	Candles per H.-P.
11793	100
7150	110
4528	120
2974	130
2015	140
1403	150
1000	160
727	170
539	180
406	190
310	200
236	210
102	220

The length of life, 11793 hours, given as corresponding to an efficiency of 100 candles per horse-power, is nearly equal to four years of average burning in working hours, and could not have been the result of actual observation, but these numbers agree very closely with the law that

$$l \propto \frac{1}{k^{5{\cdot}25}}$$

where l represents life in hours and k candles per horse-power. It is most probable that this law has been deduced from observations on the life lying within an observed range and then extended by calculation to efficiencies below those actually observed. In any case these observations are not in great discord with the above deductions made from the numbers furnished by M. Foussat on the connection between life and electromotive force in conjunction with other observations on the relation of efficiency to working pressure in the case of Edison lamps.

It is, however, far more probable that the connection between the candles per horse-power and the working pressure is expressible by a formula of this kind

$$\log k = \alpha + \beta v + \gamma v^2 + \&c.,$$

where $\alpha\ \beta\ \gamma$ are known constants ; and in this case we should have then both the life-pressure, characteristic curve, and the efficiency-pressure characteristic curve expressed by analogous equations

$$\log l = a + b v + c v^2 + \&c.$$

$$\log k = \alpha + \beta v + \gamma v^2 + \&c.$$

We have seen above that such a formula does fit in with observed values for one pair of variables. Further examination of this point is desirable. Professors Ayrton and Perry have drawn attention* to a connection between the candle-power of a lamp and the working potential, and they find that in very many cases the cube root of the candle-power is proportional to the working potential minus a constant. Now, this is equivalent to saying that the candle-power of the lamp is proportional to the cube of the potential measured above a certain point.

* "On the Most Economical Potential Difference to Employ with Incandescent Lamps." *The Electrician*, March 7, 1885, p. 348.

I have examined some records of measurements of Edison lamps to put this law to further test, and the results are given below for two 16-candle Edison lamps measured by myself, and one 8-candle lamp measured by Professor Jamieson.

Edison 16-candle Lamp.—No. 1.

Candle-power = R.	Volts v	$\sqrt[3]{K}$	$v - 57{\cdot}17$	$\frac{v-57{\cdot}17}{\sqrt[3]{K}}$
16	105·27	2·5726	48·10	18·8
11·5	99·56	2·2572	42·39	18·8
8·25	94·32	2·0206	37·15	18·4
4·8	90·03	1·6869	32·86	19
2·8	85·74	1·4095	28·57	20
2	81·22	1·2599	24·05	19·08

Edison 16-candle Lamp.—No. 2.

R	v	$\sqrt[3]{K}$	$v - 50$	$\frac{v-50}{\sqrt[3]{K}}$
16	103·84	2·5198	53·84	21·5
13	100·03	2·3513	50	21·3
9·5	97·65	2·118	47·65	22·4
8·25	94·79	2·019	44·79	22·1
7	92·89	1·913	42·89	22·3
5·5	88·12	1·765	38·12	22·2

Edison 8-candle Lamp used by Professor Jamieson.

R	v	$v - 28{\cdot}7$	$\sqrt[3]{K}$	$\frac{v-28{\cdot}7}{\sqrt[3]{K}}$
5·2	45·9	17·2	1·7324	9·928
6·2	46·7	18	1·8371	9·798
8·2	48·3	19·6	2·0165	9·720
12·9	51·9	23·2	2·3453	9·892
14·3	53	24·3	2·446	9·937
21·3	56·2	27·5	2·772	9·921
25·3	58	29·3	2·936	9·981
35·8	61·1	32·4	3·296	9·831
43·8	63·1	34·4	3·525	9·759

In these cases we see that the cube root of the candle-power is very nearly proportional to the excess of the electromotive force above a certain point. Now, on examining a number of such cases it appears that this constant is the value of that electromotive force at which the lamp just begins to give signs of incandescence. In the case of the 8-candle lamp above, Professor Jamieson marks in his table against the E.M.F. 28·7 "filament bright red." It will be very interesting if further examination should give confirmation to this surmise ; but the above figures seem to indicate that the cube root of the candle-power is proportional to the electromotive force reckoned from the neighbourhood of that pressure at which the filament begins to give out light. If we call this excess pressure the "effective volts" then we can state the rule that the cube root of the candle-power is proportional to the effective volts. We have then, according to the observation of Professors Ayrton and Perry, in a certain number of cases an empirical law of this kind

$$\sqrt[3]{K} = a\,(v - b)$$

in which K is the candle-power measured at a pressure v–

This may be written

$$\tfrac{1}{3} \log K = \log a + \log (v - b)$$

By ordinary algebraic theory we have

$$\log a = \overline{a-1} - \tfrac{1}{2}\overline{a-1}^2 + \tfrac{1}{3}\overline{a-1}^3 - \&c.$$

$\therefore$ if $c = b + 1$ we can write $\log (v - b)$ as equal to the series

$$\overline{v-c} - \tfrac{1}{2}\overline{v-c}^2 + \tfrac{1}{3}\overline{v-c}^3 + \&c.$$

and

$$\log K = A + B\,\overline{v-c} + C\,\overline{v-c}^2 + D\overline{v-c}^3 + \&c.$$

If the supposition above made is correct that b is a value not far from that pressure at which the lamp becomes incandescent, then k is seen to be an exponential function of the effective volts of a kind similar to that which has been found to reconcile very well the values of observed life and corresponding working electromotive force.

Other observers have before now called attention to the fact, that within a certain range the candle-power of a lamp varies approximately as the sixth power of the current passing.*

In the case of the above-mentioned Edison 16-candle lamp, No. 1, the following values were obtained, connecting current and candle-power.

Candle power k	$\sqrt[6]{k}$	Current in amperes a	$\sqrt[6]{k} \div a$
16	1·5874	·7582	2·09
11·5	1·5024	·7065	2·12
8·25	1·4215	·6720	2·11
4·8	1·2988	·6203	2·09
2·8	1·1872	·5859	2·03
2	1·1225	·5514	2·02

The table shows that with considerable accuracy over a range from two

* At the British Association Meeting at Montreal, Mr. Preece read a note on this subject, confirming previous observations made in 1883, and showing, from observations of his own, Professor Kittler, and Captain Abney, that incandescence varies very nearly as sixth power of current.

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to sixteen candles the incandescence varies as the sixth power of the current.

In those characteristics into which candle-power enters in any way there is a considerable difficulty in getting results with sufficient accuracy to determine the constants of the characteristic equations. There is, however, one pair of variables, namely, electromotive force and resistance, both of which can be measured with very high accuracy over a great range, and some very interesting examples of these pressure-resistance curves are given by Professor Jamieson in his memoir above alluded to.

A very short examination of the way in which an incandescent lamp behaves under increasing electromotive force shows that the resistance decreases with increase of electromotive force, but that it does not decrease without limit; it tends to a minimum value beyond which it appears to be constant. This is very strikingly shown for some of the Swan lamps tested by Professor Jamieson. In his paper certain formulæ are given connecting various lamp constants, and as a first approximation to a pressure-resistance equation is given the following :—

$$\log P = \log E + ar ;$$

when P is a constant E = E.M.F. and r = resistance.

It is not possible that such a formula should represent correctly the relation of resistance to pressure at high pressures, because it in no way expresses the fact that resistance tends to a minimum with increasing electromotive force.

An empirical formula can, however, be obtained, which will express this in the following way :—

Let R be the resistance of a lamp measured with any electromotive force, E, at the terminals. Let E_0 represent the electromotive force at which the lamp just becomes incandescent, and let R_0 the corresponding resistance. Let r be the minimum resistance to which the lamp approximates, as E increases until the filament breaks.

Then $$R = r + 10^{\log (R_0 - r) - A (E - E_0)}$$

is an expression which has the following properties :—

If $E = E_0$, then $R = R_0$,

if $E = \infty$ $R = r$.

The above formula is otherwise written

$$\log (R - r) = \log (R_0 - r) - A(E - E_0).$$

This formula has been tested for an Edison 8-candle lamp of which the resistance was measured over a considerable range by Professor Jamieson, and the resistance-pressure curve given in his paper. For this lamp luminosity commenced at 28·7 volts, and at this pressure it had a resistance of 73·4 ohms; its resistance gradually decreased with increasing pressure until it became apparently constant and equal to 53·5 ohms. Taking A equal to $\frac{1}{50}$ we have

$$50 \log (R - 53{\cdot}5) + (E - 28{\cdot}7) = 50 \log (73{\cdot}4 - 53{\cdot}5) = 64{\cdot}945.$$

Calculating R by this formula for various value of electromotive force E, we have the following table of observed and calculated resistances :—

Edison 8-candle Lamp.

E.M.F.	Resistance observed.	Resistance calculated by above formula.	E.M.F.	Resistance observed.	Resistance calculated by above formula.
28·7	73·4	73·4	48·3	62·7	61·57
32·7	71·1	70·05	51·9	61	60·34
36·1	68·1	67·65	53	60·6	60
39·7	66·4	65·49	56·2	59·3	59·13
43·1	64·7	63·78	58	58·4	58·66
45·9	63·7	62·51	61·1	57·8	57·98
46·7	63·3	62·19	63·1	57	57·58

The accordance between the observed and calculated resistances is fairly close. It seems very probable from an inspection of the values at very low electromotive forces that the resistance is a function of the electromotive force, reckoned from the pressure b, at which the lamp filament begins to be bright red, and that of R is the resistance corresponding to any electromotive force. E and r is the minimum resistance to which the lamp tends. Then

$$\log (R - r) = A + B (E - b) + C (E - b)^2 + \&c.,$$

when A B C, &c., are constants. If this should be the case, then it may be possible to express the life-candles per horse-power, candle-power, and resistance of a lamp, all as similar funcions of the electromotive force, knowing certain constants, and the two values of electromotive force at which the lamp becomes incandescent, and the resistance to which it finally tends to obtain. When, however, we are dealing with comparatively small variations of electromotive force, it is possible to calculate both life and efficiency from a simpler exponental function of the form—

$$l \propto v^x$$

$$R \propto v^y$$

when x and y are numerics. Assuming such an approximate formula, it becomes possible to deal with an interesting question, which has been discussed also by Professors Ayrton and Perry,* but which is capable of being investigated in a slightly different manner to that adopted by them in their paper. We shall take the warrant we have in the above figures for the assumption that for electromotive forces not far from those at which the lamp is intended to be used in the case of an Edison lamp, say 100 volts, that

Average life varies inversely as the twenty-fifth power of the electromotive force ;

Efficiency, or candles per horse-power, varies as the fourth power of the electromotive force ;

Candle light varies as the sixth power of the current, and therefore as the sixth power of the electromotive force, seeing that the resistance alters very little after the lamp has reached fair incandescence ;

And that therefore life varies inversely as the six and a quarter power of the efficiency, and also inversely as the four and a quarter power of the candle-power.

Let p be the price of a lamp in pounds, sterling, or fractions of a pound.

Let l be the average life in hours, c the actual candle-power, and k the candles per horse-power when run at a certain electromotive force v.

Then $\frac{p}{c\,l}$ is the cost of one candle light per hour as far as the lamp itself is concerned. Let P be the cost of 1 horse-power hour of electric energy expended in the filament. P will not be the same for all amounts, 1,000 p costs less than ten times 100 P, but for the small variations we are considering we shall consider P to be a constant. Then $\frac{P}{k}$ is the cost of the power in making one candle light for one hour, and the total cost of getting one candle light for one hour is $\frac{p}{a} + \frac{P}{k} = T$.

The first term is the expense of the translating device, and it may be called the cost of *lampage*.

The second term is the cost of the production of the energy which passes through the translating device or lamp filament and is converted into eye-affecting radiant energy, and this may be called the *machinage* ; hence the total expense of keeping going incandescent light is made up of lampage and machinage. Now, we can procure a given amount of light either by running the lamps very high, in which case lamps will cost a great deal, and power less in proportion, or we can run the lamps very low and save in lampage, whilst expending more in power in a greater number of lamps ; and the question arises, apart from capital expenditure, at what point is the greatest economy obtained, or, in other words, what proportion ought lampage to bear to machinage in order that the total cost may be a minimum? To solve this we shall assume, as is very probable, that for the limit of variation of E.M.F. employed, the average life of the lamp is an exponential function either of the candles per horse-power k, or of the candle light c, for the particular lamps considered.

Let $l = \frac{1}{k^{\alpha}}$

and $l = \frac{1}{c^{\beta}}$ be the functions,

α and β have definite values at a given E.M.F.

Then $$c\,l = l^{1-\beta} \qquad k = l^{-\frac{1}{\alpha}}$$

Substituting, we have $$\frac{1}{k} = l^{\frac{1}{\alpha}}$$

or $$p\,l^{\frac{1}{\beta}-1} + P\,l^{+\frac{1}{\alpha}} = T.$$

Now this expresses the total cost of working as a function of the average life at a certain E.M.F.

Let us also take that $l = \frac{1}{v^{\gamma}}$ where v is the E.M.F. at which the lamps are being run.

Then $$p\left(\frac{1}{v^{\gamma}}\right)^{\frac{1-\beta}{\beta}} + p\left(\frac{1}{v^{\gamma}}\right)^{\frac{1}{\alpha}} = T$$

or $$p\,v^{-\frac{1-\beta}{\beta}\gamma} + P\,v^{-\frac{\gamma}{\alpha}} = T$$

Let this be varied by varying v; to find at which value it becomes a minimum with respect to v, differentiate with respect to v, and equate to zero.

$$\frac{dT}{dv} = 0 = -\frac{\frac{1-\beta}{\beta}\gamma\,p\,v^{-\frac{1-\beta}{\beta}\gamma}}{v} - \frac{\frac{\gamma}{\alpha}\,P\,v^{-\frac{\gamma}{\alpha}}}{v}$$

or $$-\alpha\frac{1-\beta}{\beta}\,p\,v^{-\frac{1-\beta}{\beta}\gamma} = P\,v^{-\frac{\gamma}{\alpha}}$$

Hence, the total cost of working is a minimum when the cost of power, $P\,v^{\frac{\gamma}{\alpha}}$ is to the lampage $p\,v^{-\frac{1-\beta}{\beta}\gamma}$ as $\alpha\frac{1+\beta}{\beta}$ to unity.

* "On Potential Difference, &c."

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Now the above investigations show that for Edison lamps α is a quantity in the neighbourhood of $6\frac{1}{4}$ and β near $4\frac{1}{2}$,

hence $$-\alpha\frac{1-\beta}{\beta}=\frac{19}{4},$$

and hence ratio of lampage to total cost is $\frac{4}{23}=17{\cdot}4\%$.

Hence we arrive at this curious result, that independently of the price of lamp or electrical energy we must run at such a pressure that lampage is about 18 % of the total cost. Now, if instead of employing these approximate exponential expressions for the values of l, c, and k in terms of the electromotive force we had introduced the more accurate forms of equation indicated above, we should have had an equation in terms of v to solve as the result of equating the differential to zero, which would, by the introduction of the proper constants, give the value of electromotive force at which the total cost becomes a minimum. In their paper Professors Ayrton and Perry have calculated to a fraction of a volt what this economical potential is. As, however, the characteristic equations are only approximate, it seems hardly necessary to do more than obtain a similar approximate expression for the economical working.

At the Edison lamp factory in America calculations were made on the assumption of a particular type of lamp, and length of life, and cost of power to ascertain the ratio of lampage to total cost, which made the total cost a minimum, and the result appeared to be to fix it at about 16 per cent. These observations are therefore in singular accord with the deduction of theory based on determination of the constants of the characteristic curves, and are arrived at both by graphic and analytical methods.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 378.)

It may be readily objected that what the soaking with gas accomplished was not the formation of a film of gas, but a film of actual chloride, oxide, or other combination. Against this is to be urged the fact that after removal from the gas the effect diminished with time, and the plates gradually returned to nearly their former state. He tried if he could remove the gas film from one of the plates by exhaustion under an air-pump, and the plate so treated exhibited a difference when taken out and compared with an ordinary plate; but he was cautious enough to repeat the experiment, leaving the plate under the bell-jar for the same time and not exhausting. The same difference appeared, so he attributes it to possible grease.

This is the right sort of way to make experiments; and if everybody experimented with proper care there would be vastly fewer papers published, and science would progress on the whole faster.

At present it feels to me overladen with a mass of publication, mostly of necessity by men of not absolutely the first order, much of it with no sort of clearness or insight, but rough, crude, and ill-digested. A man makes a number of experiments; he does not stop to critically examine and weigh them, and deduce from their meaning, nor indeed does he often take the trouble to examine whether any definite meaning can in their then shape be drawn from them; but he rushes with them into print, producing a memoir of wearisome length and sometimes extreme illiterateness of style.

Some one else then has the trouble of wading through the heap to see whether any fragments of value may perchance be imbedded in it, and probably he is unable to come to much definite conclusion, because he cannot be in so good a position for criticism of the experiments as the original author was. He therefore writes a paper pointing out defects and errors in the communication. Others take up the same line, the original man replies, and so there is a controversy, and nothing is really settled at all. Finally, some one else independently goes over the whole ground from some distinct point of view, makes a few well-planned, clear, and decisive experiments, describes them in a compact and readable form, and there results a definite gain to science. But how much better would it have have been if this last paper had been the only one published! Unless a man is an experimental genius of the highest order, it is necessary for him to think for far more time than he experiments, if he wishes to advance and not to lumber his science. If it be objected, as indeed it may with great truth be, that one man's life and capacity are not sufficient for this in the present state of knowledge, the objection constitutes a strong argument in favour of the proposition that the time has come for an organisation of science and a more definite division of labour.

To return to the experiments of Herr Schulze-Berge, one is not able to say after all that they are very satisfactory, for they do not distinctly settle any question. The general conclusion he draws from them is the apparently safe one that the contact-force between a metal and a gas is not in general the same as betweeen a metal and air. Even this is not absolutely safe, however, because it might conceivably be that an air/gas contact-force caused all the difference. Granting that this is unlikely, the experiments are in favour of a contact-force between metals and air or gas; but they do not establish the fact any more strongly than, if so strongly as, Mr. Brown's experiments had already done. The weak point in both is the possible corrosion of the plates and formation of films of alloys or compounds, which may be the real source of the observed difference of potential.

* Reprinted from the *Phil. Mag.* for March.

And against the existence of a contact-force between metals and various gases, the experiments of Pellat and others are to be remembered, which resulted in the conclusion that a condenser made of two different metals showed nearly the same Volta effect whether the atmosphere surrounding the plates was air or hydrogen.

If it be assumed that the experiments of Brown and Schulze-Berge establish their point, and that Pellat's apparatus for different gases (Fig. 9) is satisfactory (rather a large assumption), I am unable to reconcile the discrepancy, except by suggesting that Pellat did not take sufficient pains to remove the condensed-air sheet originally on both his plates. It is of course just possible that the *difference* between the potentials of the two metals might be the same in two gases though the absolute potential of both was different, but it is improbable.

In this connection I must notice also a rather long memoir* by Dr. W. von Zahn, published in 1882, which reviews the whole subject, and describes an elaborate series of measurements made with an apparatus something like what one might suppose Ayrton and Perry's to become if it were arranged for use in different gases and *in vacuo*. He refers with admiration to Pellat's work in the preface; and I do not suppose imagines that his own numerical determinations can compare with Pellat's for accuracy where they overlap, seeing that he only makes use of a sort of combination of Kohlrausch's and Hankel's methods, with a Hankel electrometer as a measuring instrument.† He has tried, however, a large number of substances as well as ordinary metals, such as powdered antimony, iron and nickel reduced by hydrogen, many kinds of carbon, Fe_3O_4, manganite, pyrolusite, copper oxide, lead "hyperoxide," iron glance, and other minerals. He has measured the Volta effect in various gases and at different pressures, and finds, like Pellat, that it does not appreciably vary.

He has also examined the effect of temperature on the Volta effect, though he appears to think that this ought to bear some close relation to the phenomenon of Seebeck, a natural mistake many years ago when made by Avenarius, whom it led most happily, though fortuitously, to the true, and by him experimentally verified, law of E.M.F. in a thermoelectric circuit.‡ However, Zahn finds that experiment lends no support to this view, and says that a larger series of results must be obtained before basing a theory on them. Von Zahn is a confirmed contact theorist, and he victoriously assails several experiments supposed to be distinctly in favour of a chemical view of the Volta effect. He says he publishes his results because of the extraordinary discoveries being propounded by Professor Exner (such as that a thermopile will not work in a vacuum)§, and because of the vague and unsatisfactory views of physicists in general on the matter (*e.g.* of Hart); but I am bound to say that, so far as I can judge, Dr. von Zahn's own experiments are not of that conclusive and decided character that one had hoped for from his start, and he signally fails to sum up the facts in a neat and crisp manner. He adheres to the contact view, but his adhesion scarcely seems to me to be based on strong evidence; and in fact his theoretical views seem a little superficial considering the date at which he writes; so that one may admit pretty well all he says about contact and not chemical action as the cause of the Volta effect without being deeply committed to any specially true or specially false position.‖ His best experiment, and a very crucial one if only it could be perfectly performed, is the attempt to measure the Volta effect in an absolute vacuum. A pair of zinc and platinum plates are sealed up in a brass and glass vessel in such a way that one of them is capable of moving up and down, and thus of varying its distance from the other. Gravity is employed to separate the plates, the whole vessel being inverted. The vessel is filled with dry nitrogen and exhausted for some days, occasional heat, P_2O_5, and melted sodium, being employed to improve the vacuum.

The result is that the Volta effect is very decidedly "too small," going down to half a Daniell, so far as the measurements made by his not

* *Untersuchungen über Contactelektricität*, von Dr. W. v. Zahn: Leipzig, Teubner, 1882.

† A Hankel electrometer is a modification of Bohnenberger's, in which a battery with middle to earth is substituted for the dry pile; the plates on either side of the gold leaf are minutely adjustable, and the motions of the gold leaf are read by a microscope. It is sometimes preferred to a quadrant for its small capacity and dead quick motion; it can be made very sensitive, but it can hardly be a satisfactory measuring instrument. Pellat used it, but only as an electroscope.

‡ Avenarius, "Die Thermoelektricität, ihrem Ursprunge nach, als identisch mit der Contactelektricität betrachtet," Pogg. *Ann.* cxix., 1863. See also Pogg. *Ann.* cxxii., where he proceeds to calculate Volta effects from thermoelectric data.

§ I have been unable to find this extraordinary statement in Exner's works, but it is quoted again by Ayrton and Perry, Phil. Mag., 1881, p. 49. Exner seems to have said that the thermoelectric power of bismuth-antimony is destroyed by immersing the pile in pure nitrogen; and Young of Princetown takes the trouble to examine whether it is so experimentally (see *Phil. Mag.* x. 1880, p. 450), and finds the thermoelectric power of metals the same at one millionth atmosphere as at 1. This, however, would be altogether inconclusive if experiment were needed to settle it.

‖ I am afraid this is not peculiar to Dr. von Zahn. It may be that the German writers on the subject are too busy accumulating facts to care much about their precise theoretical bearing; but I notice a very loose and unsatisfactory way of putting forward secondary matters as if they were the real points at issue, and of never really getting to the heart of the matter. It is singular that the four questions or heads under which that eminent writer, Professor Wiedemann, proceeds to discuss the attempts which have been made to settle the question of the seat of E.M.F. are such that if a categorical answer to each were, by supernatural means, vouchsafed to us, we should be, I believe, none the wiser (Wiedemann, *Elek.*, vol. ii, p. 985, new edition).

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entirely unobjectionable method can be trusted ; but he does not seem to think that this is much of an argument either way, and, not finding any further change after some days, he did not pursue the investigation further by letting in some air and seeing whether the old value is restored, though he perceives clearly that this would be a crucial experiment. This abstinence is so remarkable that it seems necessary to quote his own grounds for it, and I do so in a footnote.*

Zahn goes on to describe an experiment with bright sodium *in vacuo* instead of zinc, the sodium having been long kept melted in a laterally connected bulb before being introduced into position. He finds the sodium strongly positive to copper ; but there can be nothing crucial about this experiment, I imagine, for metal in contact with glass may so easily give rise to disturbing electrifications.

I believe he must have employed the best vacuum of any experimenter on this subject, and that he has therefore gone most near to the proof of what I cannot help believing will be found to be the truth, viz., that the Volta effect in an absolute vacuum or perfectly inert gas (old air-sheets *et hoc genus omne* having been thoroughly removed) is very small. But if it be the case, as I believe it is, that the effect is almost independent of the *quantity* of oxygen present, so long as it is present, the difficulty of making the experiment so as to be sure of the absence of even the last few thousand or million oxygen molecules is almost overwhelming. The question of the dependence of Volta force on atmosphere remains thus undecided ; and all the evidence which I can adduce in favour of such dependence is this incipient decrease observed by von Zahn, the little too-mixed-up observation of Mr. Hart (described later), the measurements of Schulze-Berge, and the more decided experiments of Brown. It may, indeed, be readily held that the weight of experimental evidence tends the other way, since most experimenters on the subject (Pellat, Schulze-Berge, von Zahn, and I may add Sir W. Thomson) have left off just as pure contact theorists as they began. I would attempt an experiment myself, save that I am so profoundly impressed with the difficulty of making one in which no fault or loophole can be found, and which will by every one be deemed satisfactory and final ; so I prefer to base my views on a general survey and on fairly conclusive reasoning, rather than on a crucial but almost impossible experiment.

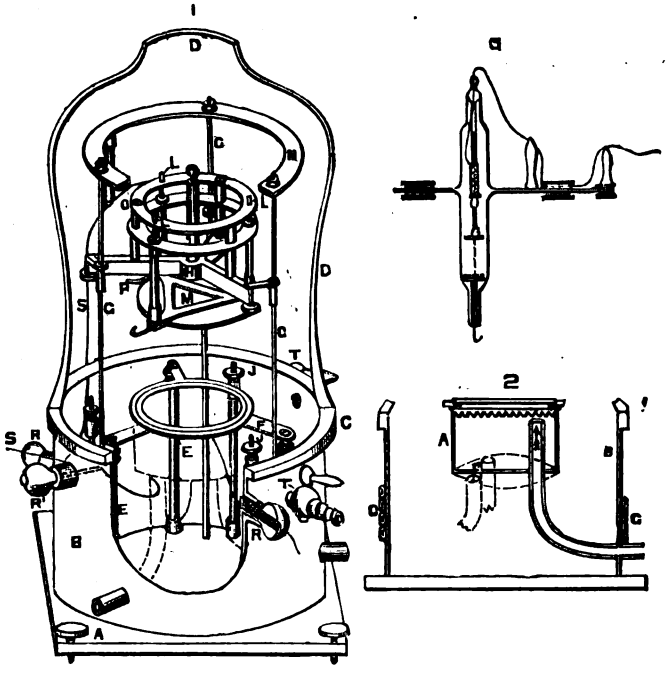

FIG. 11.—Von Zahn's Apparatus for experimenting in different Gases at different Pressures and Temperatures, and also in high Vacua.

The upper plate, M, is attached by glass rods to a sledge, H, which slides on vertical steel rods, G, being pulled up by a string. On reaching its highest point it comes into contact with an insulated platinum wire, S, which communicates with a Hankel electrometer through one of the insulated exits, R. The bottom plate is supported on the ring, E. T is the stopcock for exhaustion and change of gas. Fig. 2 shows the appendage to the bottom plate for warming it by a current of steam. Fig. 3 shows the apparatus used for high vacua. The two plates are zinc and platinum, and the platinum is arranged to fall by its own weight when the whole thing is inverted. The diagram shows it in its highest position, and just going to fall back into its dotted position. The friction of its guide-rod seems not wholly satisfactory.

5. Perhaps this is now the place to refer to the somewhat erratic series of papers by Professor Franz Exner, of Vienna*. He sets himself to disprove the existence of contact force in the most straightforward and obvious manner, and to establish the fact that there is no electrical evolution without definite and actual chemical action. To this end he announces the following propositions :—(1) that two metals in a chemically indifferent medium show no electricity ; (2) that the potential difference of two connected metals in air is exactly half the difference of their heat-combustion energies ; and (3) that two pieces of the same metal produce contact-electricity as soon as they are put into chemically different atmospheres.

The experiments by which he supports these assertions have, every one of them, been elaborately and severely criticised by Beetz, Horweg, Julius, Schulze-Berge, Von Zahn, Ayrton and Perry, Pellat, and Wiedemann ; and his numerical determinations of contact-force appear to be unique†.

It is not necessary for me to enter into a discussion on the merit of his experiments, inasmuch as the mere fact of the existence of so great a body of hostile opinion is sufficient to show that they are not of a kind best qualified to produce conviction. The theoretical views which led Professor Exner to formulate his second statement above, that the potential-difference of two connected metals is equal to half the difference of their heats of combustion per equivalent, are, I am sorry to say, quite unintelligible to me. They depend on the hypothetically necessary existence of films of oxide, between which and the metal there is supposed to be a considerable difference of potential. Perhaps a few quotations from Professor Exner's first paper on contact-electricity will render his position clearer‡. His views are but little really different from those of De la Rive and other older "chemical theo-

* "Andere etwas bessere Beobachtungsreihen gaben ähnliche Werthe. Bei allen war die Kleinheit von C. (the apparent Volta effect Zn/Pt) auffallend. Nun stellt ja dieser Werth, wie oben besprochen, nicht die Potentialdifferenz Zink-Platin dar, für seine Kleinheit muss aber eine anderweite Ursache vorliegen. Dieselbe kann ich zunächst nur darin finden, dass die Zinkplatte bei Anfertigung und weiterer Behandlung des Apparates sichtbar angelaufen ist (auf der einen Hälfte sogar blaue Färbung angenommen hat).

"Es liesse sich allerdings vermuthen, dass diese offenbar zu geringe Differenz in der wirklich wesentlichen Verminderung von Feuchtigkeit und Sauerstoff gesucht werden müsste, so dass der Apparat nach dem Oeffnen eine stärkere Spannung zeigen würde. Dies wäre dann wirklich ein *experimentum crucis* zu Gunsten der chemischen Theorie. Diese Entscheidung vorzunehmen wird aber erst dann nothwendig sein, wenn nach längerer Zeit, wo das eingeschmolzene Natrium noch mehr alle Reste von Sauerstoff beseitigt haben wird, eventuell noch Wiederhitzen und dergl. der jetzige Zustand des Apparates unverändert wieder gefunden sein wird."—*Von Zahn's Memoir*, p. 48.

*Exner, *Sitzb. der Akad. der Wissensch. Wien*: July, 1878, "On the Nature of Galvanic Polarisation ;" July, 1879, "On the Cause of the Production of Electricity by the Contact of Heterogeneous Metals ;" December. 1879. "On the Theory of Inconstant Galvanic Elements ;" May, 1880, "On the Theory of Volta's Fundamental Experiment ;" July, 1880, "On the Theory of Galvanic Elements ;" November, 1880, "On the Nature of Galvanic Polarisation ;" July, 1882, "On Some Experiments Relating to Contact Theory."

† Beetz, Wiedemann's *Annalen*, xii., p. 290 ; Hoorweg, *ibid.* xi., p. 133 (1880), and xii., p. 90 ; Julius, *ibid.* xiii., pp. 276 and 296 ; Schulze-Berge, *ibid.* xv., p. 440, as well as xii., pp. 307 and 319 ; Von Zahn, p. 41 and Preface, of his Memoir ; Ayrton and Perry, *Phil. Mag.*, 1881, p. 43 ; Pellat, *Paris Thèses*, No. 461, p. 17 ; Wiedemann, *Elektricität*, ii., pp. 992-995

‡ I quote from Mr. J. Brown's translation (*Phil. Mag.*, Oct., 1880) of a paper in Wiedemann's *Annalen* of the same year, with some abbreviations :—"An investigation concerning the nature of galvanic polarisation has led me to a quite distinct view of the origin of the so-called contact-electricity, a view which will be supported by experiments following. I have shown that the original cause of the polarisation-current is to be sought for, not at the contact of the electrodes with ions liberated on them, but in the recombination of the latter ; and the E.M.F. of the current so produced is measured by the heat-value of this combination, just as the E.M.F. of any galvanic cell is measured by the heat-value of the chemical process going on in it. With a so-called contact-action the existence of the polarisation-current, and obviously of every other current, has nothing whatever to do. The idea then suggested itself to seek for the cause of the production of electricity in the experiment of Volta, not in the contact of two metals, but in previous chemical actions of the surrounding media on their surfaces. I have expressed the opinion that so-called contact-electricity is produced by the oxidation of the metal in contact by the oxygen of the air, just as in galvanic cells it is evolved by oxidation of zinc. If the supposition prove true, and it has proved true, the E.M.F. of his metal in contact in air must be measured and expressed by their heats of combustion."

He then points out how all Volta tension series are in oxidation order, and relates approvingly De la Rive's view that metals in air were attacked not only by water-vapour but by dry oxygen, and that electricity is produced by any kind of chemical action in proportion to the intensity of the chemical affinity. Then he gives his numerical theory and supporting experiments ; and finally concludes : "I believe we are entitled to say that no *Scheidungskraft* exists at the contact of two metals." The following must take the place of Volta's law of the evolution of electricity :—"The difference of electric potential between two metals in contact is measured by the algebraic sum of the heat value of the chemical action going on at each."

In his theory and experiments, and all through the rest of the paper, he considers the difference of potential equal to *half* the difference of heat-values, so the above last statement must be a slight numerical slip.

The above extracts are among the most favourable. It would be easy to select passages from this, and from his other memoirs on the subject, of a more surprising character.

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rists;" but they are (especially in later papers) expressed in so definite and decided a manner that they have excited a sharper controversy than vaguer and more hesitating writings could. This, indeed, may be regarded as their special merit. The main objection which can be taken to them relates to the quantitative statements; these are vigorously made, but they seem unwarranted by facts accumulated by all other observers, though, indeed, some of his own experiments certainly seem to support them. It has also been objected that he misinterprets some of his experiments.

He has got hold of the notion that the heat of combustion has some sort of relation to the Volta effect, and there I am heterodox enough to agree with him. But what the relation is, and how it acts, and what sort of potential-difference you ought to expect in accordance with theory, concerning all these things I am utterly at variance with him; and I deem it prudent not to attempt to represent views which I am unable to understand, because it is unlikely that I should do them justice.

Professor Exner, to strengthen his position, adduces a large number of very simple experiments (such as connecting first one Daniell and then two Daniells to an electrometer, and observing that in the second case the deflection is double the first), and from them he obtains equations proving algebraically that Zn/Cu = 0. Considered as conundrums these equations are ingenious, but it is a waste of time seriously to discuss them as Herr Julius has done in an elaborate manner. To suppose that such everyday experiments as these are in direct contradiction of the contact theory is scarcely complimentary to the great men who have held, and who still hold, that view.

Dr. C. G. Knott, in 1879,* examined the contact force between plates of the same metal at different temperatures, using the condenser or Kohlrausch method. He found that iron, copper, zinc, and probably tin, were negative when hot to the same metals cold; and the effect increases uniformly with temperature. But it is permanent, remaining after the hot plates have cooled down; hence it must be due to oxidation.

A slow oxidation proceeds with time alone. Time-curves are logarithmic like cooling-curves, and the most oxidisable metal varies most quickly both for time-variation and temperature-variation. There seems to be a surface-condition of a metal proper to each temperature which no polishing can change, for it establishes itself in a few seconds after cleaning, and only changes with temperature.

Mr. S. Lavington Hart, in 1881†, describes a mercury-dropper where the mercury is contained in a funnel, and is connected with an electrometer by an iron rod dipping into it. The drops form inside an iron inductor, and they fall negatively charged. Mr. Hart so far ignores any Volta force that he considers the arrangement as an inversion of Lippmann's electrometer, the advancing drops being oxidised. It can plainly be regarded, however, as a mere Fe/Hg contact arrangement; and that is what I suppose it to be. He makes two interesting modifications; the first is to replace the air round the dropping mercury by coal-gas; the electrical effect is then zero. This is interesting, because the exuding drops of mercury, unlike most pieces of metal, expose to the coal-gas a virgin surface which has probably contracted no condensed air-sheet; only coal-gas is a rather sophisticated substance for it to be first exposed to. If the experiment is regarded as sufficiently direct and simple, this fact lends support to the view that Volta forces depend on the medium surrounding the metals.

The second modification is to bring an earth connected iron bar close to the drops, and to show that it reduces the deflection. Mr. Hart thinks it reduces the oxidation by proximity; and certainly, provided the obvious action of a mere electrostatic screen has been considered and provided against, the action by proximity is very remarkable. A similar effect has been observed and more fully worked out by Pellat, in a paper published in 1882.‡ Pellat says that if he places two metallic surfaces parallel to one another and very close together (say half a millimetre more or less, variations from 12 to ·1), each metal undergoes a slight alteration of the properties of its superficial coat. The alteration takes some minutes to produce, increases with time, but tends to a limit. When the influencing metal is removed the other returns gradually to its primitive state. Lead and iron produce the largest influence effects; copper, gold, and platinum give smaller but distinct effects; zinc produces hardly any, unless it be put within a hundredth of a millimetre or so. Pellat does not attempt to account for this interesting phenomenon further than by suggesting some possible connection with the smell of metals.

Mr. Hart's theoretical views are at first sight somewhat analogous to my own, though they are by no means the same. He considers the case of two metals immersed in liquid electrolytes, and dismisses air by calling it a gaseous electrolyte. He believes zinc and copper in contact to be at the same potential, and throws the variation of potential on the air between them.§ He considers the electrical effect brought about by the electro-negative ion oxygen combining with the zinc and charging it negatively, while some electro-positive ion combines with the copper and charges it positively, "though not unless the two metals are in sufficient proximity to overcome electrolytic diffusion" (whatever that may mean as applied to this case). He thinks his mercury-dropping experiment in coal-gas is conclusive as the equality of potential of metals in contact. This, I fear, is rather rapid induction. I do not see how it follows on his own hypothesis that his arrangement is virtually a reversed Lippman electrometer.

Sir W. Thomson's dropping arrangements, or voltaic cells, in which gravity does the work instead of chemical action, are so well known that it is scarcely necessary to do more than refer to them. Mr. Hart's mercury dropper is scarcely a modification of the copper filing dropper shown in Fig. 12. Sir William also shows how to couple up such cells in series,*

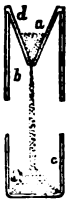

FIG. 12.—Thomson's Gravitation Voltaic Cell.

a copper filings. *b* inductor—zinc. *c* receiver. *d* copper funnel.

The copper filings drop negatively charged against electrical forces. If you join *c* and *d* by a copper wire, you can get a current flowing wholly through and with copper.

and how to construct a mechanical replenisher on the Volta principle (Fig. 13).

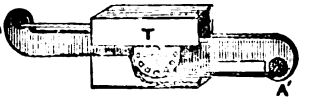

FIG. 13.—Thomson's Voltaic Induction Machine.

One of the inductors, T, is lined with one metal, the other with another, and the two connected. The carrier wheel is rotated, and the contact springs, A, A', become oppositely charged. By afterwards charging the inductors with a Daniell cell, and comparing the deflection now produced in an electrometer connected to A, A' with what it was before, measurements of Volta effect can be obtained; or of course it can be made a null method.

6. In order to give this historical sketch more completeness, it may be as well to record rapidly such other memoirs as I have been able to get acquainted with: it is in the highest degree probable that several are omitted, but I hope no very important ones. Professor Wiedemann's collection of views and memoirs bearing on the subject is at the end of the second volume of the new edition of his *Elektricität*.

Edlund has published a long paper† in which he investigates experimentally the Peltier effect; he points out clearly at the end that there is no relation between the Peltier and Volta effects; and he suggests that this is because of the contact-force between the metals and the gas or air in which they are, the fact of such contact force being, he thinks, sufficiently established by gas-batteries and galvanic polarization.‡

Majocchi, in a paper printed in *Phil. Mag.* xxx. p. 97, regards the E.M.F. of contact as due to the "adhesion" of the two metals for each other: pretty much the same idea as Sir W. Thomson's chemical action at a distance, an idea which makes the energy of the Volta effect Zn/Cu depend on, and be calculable from, the combination-heat of zinc and copper in making brass. I must return to this matter later, because it is important in itself and crucial as regards theory.

Gassiot§ made an experiment intended to show that there could be a difference of potential excited between metals by proximity without actual contact, or at any rate without metallic contact. Grove‖ also made a similar experiment.

Hoorweg¶, and also Nobili**, have a theory that all galvanic currents are really thermoelectric.

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* Knott, *Proc.* R. S. Edinb. 1879–80, No. 105, p. 362.

† Hart, Brit. Assoc. York, p. 555; and *Phil. Mag.*, November, 1881, ser. 5, xii., p. 324.

‡ *Comptes Rendus*, xciv. (1882) p. 1247: "Influence of Metals on one another at a Distance."

§ The diagrams of potential which Mr. Hart gives of cells were given more fully by Professor Exner in his paper on the Theory of Galvanic Elements (1880). Mr. Hart's views are, in fact, rather similar to some of the more reasonable ones of Professor Exner.

* Electrostatic Reprints, p. 325.

† Edlund: Pogg. *Ann.* cxxxvii., p. 474; cxl., p. 435; cxliii., pp. 404, 534. See also *Phil. Mag.* [4] xxxviii., p. 263; xliii., pp. 81, 213, 264, especially p. 273.

‡ Sundell investigates the E.M.F. of alloys in contact with copper, employing Edlund's method, and finds, like him, that for alloys as well as for simple metals the Peltier corresponds with the Seebeck force. The peculiar language used in this and the preceding paper may easily cause it to be imagined that they have found Volta force to agree with Peltier. In fact, Sundell is so quoted in Watts's 3rd Suppl., p. 708. Von Zahn quotes Edlund in the same sense; and indeed it is probable that Edlund himself at first thought he was investigating Volta forces thermoelectrically (Pogg. *Ann.* cxlix., p. 144).

§ Gassiot, *Phil. Mag.* xxv., 1844, p. 283.

‖ Grove, *Literary Gazette*, Jan. 21, 1843; Wiedemann, *Elek.* ii, p. 988.

¶ Hoorweg, Wied. *Ann.* ix., p. 552, 1880; xi., p. 233; and xii., p. 75.

** Prof. Wiedemann notes as interesting that in 1828 Nobili held a notion that all galvanic currents are thermoelectric, thus vaguely anticipating the modern thermodynamic theory of E.M.F. See Wied. *Elek-*

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In the article "Electricity" in the *Encyc. Brit*, p. 99, Professor Chrystal gives some clear general considerations regarding the seat of E.M.F. and the opposing views which are held with regard to it. He is judicial in his attitude with regard to them; but the mere statement of the position in so clear a form is in itself a powerful argument for the views held by Maxwell.*

Professor Fleeming Jenkin, in the last edition of his "Electricity and Magnetism," p. 216, endeavours to reconcile the contact and chemical theories. According to the chemical theory, the E.M.F. of a cell $= \Sigma(J\theta\epsilon)$; according to the contact-theory it is $C/L + L/Z + Z/C$. On these undoubted facts he proceeds to found a number of statements which are true†, though scarcely simple; in fact, they perhaps rather tend to complicate what may be held to be a simple matter.

Schönbein, in a letter to Faraday published in the *Philosophical Magazine* for 1838,‡ throws out a remarkable suggestion with regard to "chemical tendency" as the possible source of a current, or rather of "force electromotive." His language and ideas are in many respects old-fashioned and erroneous; he uses such phrases as "a current of tendency," he supposes currents with no electrolytic power to exist, and of course is not troubled about energy considerations. But I feel little doubt, that had he lived later he would have held that while *currents* were due to chemical action, *electromotive force* was due to "chemical tendency;" and this is pretty exactly my own view of the matter.

I have only just discovered this Schönbein letter; and I have also found some paragraphs in Faraday which more in detail and with fair distinctness express what I believe to be the true view. (See §§ 893—900, Exp. Res. vol. i.§)

Various observations regarding the E.M.F. of different cells are made in the series of papers still appearing in the Philosophical Magazine by Dr. Alder Wright and Mr. C. Thompson, "On the Determination of Chemical Affinity in terms of E.M.F."

For much discussion of contact-electricity and for some interesting statements of the views of Marianini, Davy, and others, refer to 'Experimental Researches,' vol. ii. p. 20, &c. From what is there said, it appears that Karsten and Marianini held a modified contact theory, placing the E.M.F. at the metal-fluid junction; and that Becquerel admitted as a possibility the efficiency of chemical attraction, as distinct from combination, something in the same way as Schönbein.

Professor Tait in his 'Thermodynamics' lends his powerful support to the contact view of the activity of the pile as taught by Sir W. Thomson.

Some work has been done in the direction of observing reversible heat-effects at metal-liquid junctions, notably by Joule, Thomson, and Bosscha. We shall have occasion to refer to this work later.

Joule in 1841 sent currents through several dilute acid voltameters with different electrodes, and measured the excess or reversible heat $H - RC^2$ generated in the whole cell; with the result that the excess of heat observed is that due to the observed back E.M.F. of the cell, minus that concerned in the decomposition of water. A table of his results is given by Chrystal, *Encyc. Brit.*, p. 91. For Maxwell on the same subject see "Elementary Electricity," p. 146.

Thomson (Math. and Phys. Papers, pp. 496, 503) says that, of two decomposition cells, one with zinc cathode, the other with platinum cathode, the former showed the most heat when the same current was sent through both. Separating the electrodes by a porous cell, zinc cathode showed more heat than zinc anode, but platinum anode more heat than platinum cathode*. He speaks of the local heat developed at a tin surface, and shows that it is greater where hydrogen is liberated than where tin is dissolved; and suggests thermal observations on four dilute-acid voltameters in one circuit with zinc and platinum electrodes, arranged according to the permutations—zinc-zinc, zinc-platinum, platinum-zinc, and platinum-platinum. Thomson attributes the extra heat at an electrode to opposing chemical affinities which have to be overcome—a doctrine of "chemical resistance."

Bosscha examines and develops all these matters in a series of interesting papers published about 1857.† He attributes the development of local heat, at a cathode against which hydrogen is liberated, to the change of hydrogen from the nascent condition to the ordinary one—in other words, to the energy of the molecular combination H, H. He finds the electromotive forces exhibited by this local generation of heat at the surface of different metals in acid to have the following values in volts:—

Pt	Fe	Cu	Sn	Hg	Zn
·45	·49	·64	·86	1·2	1·2

One more memoir I must mention before closing this historical sketch and discussion thereon, a valuable communication by Bouty to the *Journal de Physique*‡, "On Thermoelectric Force at Contact of Metals and Liquids, and on the Peltier Effect thereat." He finds the Peltier coefficient at a junction of copper with salts of copper eighty times as great as at an iron-zinc junction, and eleven times as great as bismuth-copper. He also

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tricität, ii., p. 985, and Nobili, *Bibl. Univ. de Genève*, xxxvii., p. 118. But Prof. Hoorweg seems bitten with the same idea in recent times, and in 1879-80 writes long papers in proof that all current-energy is due to absorption of heat at junctions!

* Although this article is, or ought to be, easily accessible to everybody, there is one important suggestion in it which it is as well to quote, viz., that contained in the following sentence:—"We are so ignorant of the nature of the motion which is the essence of the electric current that the very form in which we have put the question (as to the locality of E.M.F.) may be misleading. If this motion be in the surrounding medium, as there is great reason to believe it to be, it would not be surprising to find that speculations as to the exact locality of the E.M.F. *in the circuit* were utterly wide of the mark." Prof. Willard Gibbs suggested something of the same sort at Montreal, though in a rather vaguer form. I do not myself feel any doubt that a precise location can be given to the E.M.F., notwithstanding that much of the current energy exists in the medium. The most complete attention to the distribution of energy in circuits which has yet been bestowed on the subject has been given by Prof. Poynting in his remarkable memoir (*Phil Trans.*, 1884), and he therein locates the E.M.F. of a battery exactly where I do myself.

† Except, indeed, a doubtful statement at the end of No. 2 and an erroneous bit of reasoning at the end of No. 4, though the conclusion drawn is correct.

‡ Schönbein, *Phil. Mag.*, vol. xii., pp. 225 and 311. The two most striking sentences are here extracted:—

"Before closing my letter, allow me to communicate to you in a general manner the view which I have taken of the subject in question. In the first place, I must tell you that I am by no means inclined to consider mere contact in any case as the cause of the excitement of even the most feeble current. I maintain, on the contrary, in accordance with the principles of the chemical theory, that any current produced in a hydro-electric voltaic circle is always due to some chemical action. But as to the idea which I attach to the term 'chemical action,' I go further than you and M. de la Rive seem to go; for I maintain that any tendency of two different substances to unite chemically with one another must be considered as a chemical action, be that tendency followed up by the actual combination of those substances, or be it not; and that such a tendency is capable of putting electricity into circulation."

And on page 314 he explains this last phrase, which he has elsewhere called a "current of tendency," thus:—

"As what I term a current of tendency is no doubt in some cases nothing but that electrical state which the Voltaists consider to be the effect of their 'force electromotive,' or of contact, it appears to me that, from some of the facts above stated, a specific and most important conclusion regarding the theory of the pile can be drawn. Even if we grant to the Voltaists our current of tendency to be the effect of mere contact, the facts alluded to prove that such a current does not possess a sensible degree of electrolysing-power; consequently that the chemical effects of the common voltaic arrangements have nothing to do with current-electricity excited by contact."

§ Extract from Faraday's 'Experimental Researches,' vol. i.:—

"(893) The use of *metallic contact* in a single pair of plates and the cause of its great superiority above contact made by other kinds of matter, become now very evident. When an amalgamated zinc plate is dipped into dilute sulphuric acid, the force of chemical affinity exerted between the metal and the fluid is not sufficiently powerful to cause sensible action at the surfaces of contact, and occasion the decomposition of water by the oxidation of the metal, although it is sufficient to produce such a condition of the electricity (or the power upon which chemical affinity depends), as would produce a current if there were a path open for it; and that contact would complete the conditions necessary, under the circumstances, for the decomposition of water.

"(894) Now, the presence of a piece of platina touching both the zinc and the fluid to be decomposed opens the path required for the electricity. Its *direct communication* with the zinc is effectual, far beyond any communication made between it and that metal (*i.e.*, between the platina and zinc) by means of decomposable conducting bodies, or, in other words, *electrolytes*, as in the experiment already described [that of decomposing iodide of potassium without metallic contact by interposing it on blotting-paper between the platinum and the zinc of a simple voltaic cell], because, when *they* are used, the chemical affinities between them and the zinc produce a contrary and opposing action to that which is influential in the dilute sulphuric acid; or if that action be but small, still the affinity of their component parts for each other has to be overcome, for they cannot conduct without suffering decomposition; and this decomposition is found *experimentally* to react back upon the forces which in the acid tend to produce the current, and in numerous cases entirely to neutralise them. Where direct contact of the zinc and platina occurs, these obstructing forces are not brought into action, and therefore the production and the circulation of the electric current, and the concomitant action of decomposition are then highly favoured.

"(895) It is evident, however, that one of these opposing actions may be dismissed and yet an electrolyte be used for the purpose of completing the circuit between the zinc and platina immersed separately into the dilute acid; for if in the above experiment the platina wire be retained in metallic contact with the zinc plate, and a division of the platina be made elsewhere, then the solution of iodide placed there, being in contact with platina at both surfaces, exerts no chemical affinities for that metal; or, if it does, they are equal on both sides. Its power, therefore, of forming a current in opposition to that dependent upon the action of the acid in the vessel is removed, and only its resistance to decomposition remains as the obstacle to be overcome by the affinities exerted in the dilute sulphuric acid.

"(896) This becomes the condition of a single pair of active plates where *metallic contact* is allowed. In such cases, only one set of opposing affinities are to be overcome by those which are dominant in the vessel; whereas, when metallic contact is not allowed, two sets of opposing affinities must be conquered (894)."

* Showing, I suppose that while zinc attracts oxygen much and hydrogen not at all, platinum attracts hydrogen more than oxygen.

† Bosscha, Pogg. *Ann.* vols. ci., ciii., cv., cviii.

‡ Bouty, *Journal de Physique*, 1879, viii. p. 341; ix. pp. 229 and 306, especially p. 306.

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measures the metal-liquid thermoelectric E.M.F. at different temperatures, and shows that Thomson's thermodynamic formula

$$\Pi = \frac{T dE}{dT}$$

is perfectly true and in agreement with experiment in these cases also. He endeavours to see if this Peltier, or, as we had better call it for distinction, Joule or Bouty effect, can be calculated from the energies of combination. After tabulating his results alongside of heats of oxidation and heats of solution, he decides that it is hopeless, and that we must give up trying to establish a relation between these quantities. Chemical action, he concludes, only disturbs the effect by altering the surfaces, and by developing parasitic heats. They may mask, but they do not produce, the true Bouty phenomenon, which he believes is probably physical.

The difficulties of making these measurements are exceedingly great; and, notwithstanding the ingenuity and skill displayed, it seems to me possible that some error or unexpected source of disturbance may have modified the results. So far as I know, they have not yet been repeated; and I can hardly regard the experimental method used as perfectly safe.*

[TO BE CONTINUED.]

THE INSTITUTION OF CIVIL ENGINEERS.

At the meeting on Tuesday, the 24th of March, Sir Frederick J. Bramwell, F.R.S., President, in the chair, the paper read was on "The Electrical Regulation of the Speed of Steam Engines and of other Motors for Driving Dynamos," by Mr. P. W. Willans.

The author referred first to the necessity for electrical governors in arc lighting, and other cases where a constant current was required, and where the resistance of the circuit was variable. He then alluded to the irregularities in incandescent lighting caused by the resistance of the armature, the resistance of the leads, the material of the field magnets, or to these causes combined. He went on to say that there were cases in which the length of the mains, the cheapness of the power employed, and the necessity for economy in first cost, would make a reduction in the section of the leads desirable, were it not that such a reduction introduced serious irregularities in the lighting. What was required in such cases was an electrical regulator which would ensure a constant difference of potential where the light was used, rather than where it was generated. The error due to the resistance of the leads was of the same nature as, and must be added to, the error due to variations in speed when a centrifugal governor was used; and it was pointed out that centrifugal governors in no way compensated for the loss in electro-motive force due to the heating of the dynamo either from within or from without. Attention was directed to the difficulty of winding compound dynamos for each circuit, and to the fact that subsequent changes in an installation might upset the most careful compounding. The author then alluded to the well-known difficulty of ensuring that each of several machines connected to the same mains did its fair share of work, and he pointed out that a shunt machine combined with an electrical regulator effected a reduction in the loss due to the mechanical friction of the motor when the load was not at its maximum. Many of the earlier electrical governors had been designed with a view to the maintenance of a constant speed of engine, but, so far as the author was aware, none of them had had any extended practical application.

After alluding to the governors of Lane-Fox, Sawyer and Man, Andrews, Richardson, Carns-Wilson, and Westinghouse, the author stated that the older forms of governor might be broadly divided into three classes. 1st. Those in which a centrifugal governor was used in conjunction with an electro-magnet, and he observed that these were necessarily complicated, and that they combined some of the disadvantages of both classes of governors. 2nd. Those in which the electro magnet did the whole work of moving the throttle valve. These, the author considered, could not be depended on, because the electro magnet had too much to do. 3rd. Those in which an intermediate relay of power was used, which he considered had the necessary power, but had not the necessary control over it. He next referred to Mr. Jamieson's and Mr. H. S. Maxim's governors, and expressed surprise that Mr. Jamieson in his paper on the electric lighting for steamships insisted on the necessity of a self-regulating dynamo.

The author did not claim to have been the first to recognise the advantages to be expected from electrical regulation; but he believed he had been the first to secure a practical success, as his governor had been adopted in more than fifty instances. He then proceeded to describe in detail governors in which he employed a differential connection between the core of the regulating solenoid and the relay mechanism, so as to ensure that the former should move in perfect unison with the throttle-valve or expansion gear. He explained by diagrams the experimental governor made two and a-half years ago, and showed the governor itself in action, so far as its hydraulic mechanism was concerned. He described the difficulties encountered at first, and explained that these were mainly due to the core of the solenoid not moving in unison with the regulating mechanism of the engine. The two got, as it were, into cross time, and the result was hunting, and consequent serious fluctuations in the light. He explained how these difficulties were eventually overcome, and went on to describe the ordinary form of the governor as used for regulating the position of the throttle-valve. This governor was fitted with a safety arrangement, in case of the belt breaking or the main lead being severed, and was much more simple in its action than the original experimental governor. He gave figures showing the expenditure of power in the core of the solenoid, which, in the case of a 60 horse-power engine, was not more than one-half that absorbed in a 20 candle-power Swan lamp. He showed graphically, by means of diagrams, the method adopted for balancing the core by a spring, and explained how the governor could be made either more sensitive to minute changes in current, or more stable, so as to avoid oscillation in the case of sudden variations in the load. The results were given of various experiments made with cores of different proportions, with a view to determining the best for the purpose; and the action was explained of a particular form of reducing-valve, which could be used in connection with the governor where absolute accuracy was required. The author next described the governor now in use at the Edison and Swan Company's installation at Victoria Station, and gave a chart of its performance, which showed great accuracy, a variation in electromotive force of one volt being the greatest observed during four hours, although the variations in steam pressure and currents were very considerable during that time. He then described a governor suitable for controlling the expansion gears of powerful engines, and stated that the friction of the regulating mechanism in this governor did not exceed one-fifth of an ounce, and that the power available for the work was upwards of 500lb. acting through six inches. He mentioned that in addition to their application to the regulation of the speed of motors these governors might be applied with advantage to insert resistance in a circuit, where the speed of the engine could not well be varied to suit the exigencies of the lighting. He then proceeded to describe a duplex governor suitable for one of the units of a large installation, which not only determined the difference in potential in the mains, but regulated the currents generated by each unit. In conclusion, the author alluded very briefly to the use of electrical relays. These, he stated, had not yet been used, but had in many cases considerable advantages. He showed several governors, and the promptness of their action was seen as they were connected to the water main. He also exhibited some of the governors in pieces, and their details were fully explained by the aid of diagrams.

At the ordinary meeting on Tuesday, March 31st, at eight p.m., the discussion upon Mr. Willans's paper, "The Electrical Regulation of the Speed of Steam Engines and of other Motors for Driving Dynamos," will take place.

* I find that a method exactly like that used by Bouty was suggested by Clerk Maxwell, "Elementary Electricity," p. 146.

COMPANIES' MEETINGS & REPORTS.

German Union Telegraph and Trust Company (Limited).

The fourteenth ordinary general meeting of shareholders of this Company was held at the office, 66, Old Broad-street, under the presidency of Sir James Anderson.

The SECRETARY (Mr. Wm. Payton) read the notice calling the meeting and the minutes of the last ordinary meeting, which were approved as correct by the present meeting.

The CHAIRMAN then said: Gentlemen, before moving the resolution that the report be adopted, I have one or two remarks only to make. The first is one that is satisfactory in the extreme. The Berlin Company have, as you will see by the accounts, £50,000 of reserve, and in addition £18,000 of unissued capital; that is, 68,000 sovereigns in hand upon a capital which the Berlin Company represents of £300,000. That is, I think, a very satisfactory statement, for in the absence of a reserve fund no telegraph company can in our opinion be solvent. The next remark I would make to you refers to what is stated in paragraph 5 of the report. We there say that the traffic has shown a small increase in the number of telegrams, but there has been a decrease in the average number of words in each message. The decrease in the number of words has produced a diminution in the receipts which is not compensated for by the increase in the number of telegrams sent. Now, that means something that is coming to the front very fast in telegraph companies. The fact is you are aware the Telegraph Conference allows eight languages for telegraph purposes, and those languages are to be employed according to the usages of the languages. Merchants may use all the words of these eight languages for coding purposes in any manner they please, and no exception would be taken by the companies on that account. But I am sorry to say that, within the last few months especially, there have come out a number of codes utterly defiant of all language, having no relation at all to language except that they are syllabate combinations of two letters, thus making a great difference in the receipts of every telegraph company of this country. The Anglo-American Company are feeling it, the Direct Spanish Company cannot pay a dividend very much on account of this cause, and their receipts are going down, and in the German Union Company you find that the receipts are going down, and that there is no improvement by the increase in the number of messages. The merchants are taking every advantage, and I think we shall see in the course of a short time that the companies will have to cry out against such a system. I have ventilated this matter now for the first time because we all considered it, and the Indian Government and the Post Office have also the matter before them, and I dare say at the next conference in August this subject will be discussed in the interest of every telegraph administration, both foreign and English. I do not think there is any other point, happily, worth referring to. I would mention there is a decrease in our expenses of some £27, and the dividend is some 4 per cent. less than last year. Considering the opposition of the Atlantic cable, the reduction of the tariff, and the depression of trade, I think that is a very

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satisfactory result. The German Union Company, with its well-placed cables between Germany and England, stands as good a chance of being a permanent telegraph property of value as any I know of. I now propose "That the report and accounts for the year ended 31st December, 1884, submitted to this meeting be and they are hereby received and adopted, and that a dividend of 5s. 6d. a share be declared, payable this day, free of income tax, making, with the previous distribution of 5s. 9d. per share, a total dividend for the year of 11s. 3d, or at the rate of £5 12s. 6d. per cent. per annum."

Mr. H. G. ERICHSEN seconded the motion.

Mr. GRIFFITH acquiesced in what the Chairman said that the report was of such a satisfactory character that it did not offer much ground for discussion. He had only one question to ask, which he did to obtain information on the point, namely, whether the new cables laid between this country and the United States were likely to affect beneficially or adversely the submarine cable from Germany to Valentia by which the Germans had direct communication with the United States? The point to which the Chairman had especially called the attention of the meeting was a most important one. If telegraph companies did confer so much benefit on commerce, he thought merchants ought to do only what was fair, and if merchants increased their profits, the profits of the telegraph companies ought to increase at the same time. He was sure that any measures which the Board thought fit to take for protecting the shareholders' interests would meet with their co-operation. Union was strength, and it might be suggested that the companies should act together in discussing such a question. He was glad to hear that the Post Office were inquiring into the matter, for it was a subject that affected imperial as well as individual affairs. He thought with such a combination, and with the talent which the shareholders had the advantage of on the telegraph Boards, their interests would be fully protected.

The CHAIRMAN, in answer to Mr. Griffith's question, said: I may perhaps refer to the Berlin Company's report, in which they say that the Mackay-Bennett Atlantic cables, "have deprived us of a fraction, though a very small one, of the traffic." They point out that the Valentia cable, which is laid from Valentia in Ireland to Emden in Germany, gives such very rapid communication that we are able to retain practically the whole of the traffic, and no doubt we should do our best to continue to do so. Still, competition and low rates cannot always be good.

The resolution was then put to the meeting and carried unanimously.

On the motion of the Chairman, seconded by Mr. John Denison Pender, Count Oscar von Reichenbach was re-elected to his seat at the Board.

Mr. FORD next moved and Mr. GRIFFITH seconded the reappointment of Mr. Henry Dever as auditor for the current year, and the motion was unanimously agreed to.

The CHAIRMAN: That is the end of the business, but I may add, in reference to what Mr. Griffith said, that I find that the average time occupied in transmitting a message from Germany to New York is one hour.

Mr. JOHN PENDER, M.P.: I think before we part that we ought to pass a vote of thanks to the Chairman and Board of Directors. The question which the Chairman referred to just now in regard to this coding is one which I am sure will require to be looked into by all the different companies. While the public as a rule are entitled to do the very best they can to cheapen the system of telegraphy, on the other hand the Directors of the companies must take care that their shareholders' interests are duly and properly protected. I am quite sure that in the hands of Sir James Anderson and the other gentlemen connected with submarine telegraphy the matter will receive the most careful and impartial consideration.

Mr. FORD seconded the motion, which was carried unanimously.

The CHAIRMAN: We are obliged to you for this vote expressing your confidence in us, and we will do the best we can to deserve it.

The proceedings then terminated.

Montevidean and Brazilian Telegraph Company (Limited).

The ordinary general meeting of this Company was held at the offices, Tokenhouse-buildings, Moorgate-street, on the 25th inst., under the presidency of Sir Thomas Gore Browne, K.C.M.G.

The report of the Directors for the year ended 31st December last stated that the Company's percentage of the gross earnings of the Western and Brazilian Company for the year were estimated at £1,860—a reduction of £380 as compared with the preceding year, or of about £900 as compared with 1882. The Directors were informed that this serious diminution in the Company's income arose mainly from the great reduction in rates which competition had compelled the Western and Brazilian Company to adopt. The balance to the credit of revenue account amounted to £582, out of which £500 had to be set aside for redemption of debentures, leaving a net balance of £82, which would not admit of the payment of any dividend, and would be carried forward to next account.

On the motion of the CHAIRMAN the report was adoped, and the retiring Director, Mr. Charles Cameron, M.P., and the auditor, Mr. W. S. Ogle, were afterwards re-elected.

Direct Spanish Telegraph Company (Limited).

By the report of the Directors ended 31st December, 1884, to be presented at the general meeting of shareholders, at the Cannon-street Hotel, on Monday, the 30th inst., the accounts for the half year ended 31st December, 1884, show a balance to the credit of profit and loss of £4,486 0s. 9d. The traffic receipts show a falling off of £318 17s. 4d. as compared with the corresponding half year of 1883. This decrease is principally due to the quarantine regulations in Spain during the prevalence of cholera in the Mediterranean. The original Bilbao cable, as mentioned in the last report, broke down on the 17th July, and continues interrupted. The new Bilbao cable and the Marseilles-Barcelona cable have continued in perfect working order. After applying £335 14s. 7d. to close the preliminary expenses account, there will remain a balance of £4,150 6s. 2d., of which it is proposed to put £4,003 14s. 2d. to the reserve fund, which will then amount to £5,000, and to carry £146 12s. to the next account. On the 14th of January the Directors issued the following circular to the shareholders; since then another break has occurred in the original Bilbao cable:—"Since the last half-yearly report was issued, in which it was stated that the Directors did not contemplate restoring the original Bilbao cable at present, another break is known to have taken place in it, and the Board have, after careful consideration, come to the conclusion that a thorough examination of the whole cable is necessary. This, therefore, will be undertaken as soon as the season permits, and it is hoped that the exact amount required for the re-instatement of the cable may be known before the half-yearly meeting in September. In the meantime the reserve fund being practically exhausted, the Board are advised by eminent counsel that no dividend can properly be paid upon either class of the Company's shares until adequate provision has been made for the re-instatement. While they much regret to announce that the usual dividend cannot, under the above circumstances, be paid next March upon the Preference Capital, the Directors would remind the Preference Shareholders that their dividend for the past half year, and any further dividends which may have to be withheld from them, will be payable (under the terms on which the shares were issued) out of the first available profits of the Company. The new cable continues in perfect working order, and the revenue for the past half year was, as nearly as possible, the same as for the corresponding half of 1883. Since the last general meeting Mr. Bannatyne and Mr. Scott, in consequence of engagements with other companies, have resigned their seats at this Board." Sir James Anderson and Mr. Etlinger are the Directors retiring by rotation, and, being eligible, offer themselves for re-election. The auditor, Mr. Herbert R. Duke, retires, and offers himself for re-election.

Business Notice.—We are asked to state that Mr. Henry Edmunds has retired from the firm of Messrs. Edmunds and Goolden, electrical engineers, of Westminster and Halifax, and that Mr. A. B. Trotter, B.A., Cantab, the inventor of the Trotter Dioptric system of light distribution, has entered into partnership with Mr. W. T. Goolden, M.A., Oxon, and, with him, will continue the business of the late firm under the style of Goolden and Trotter.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. MAR. 25.		BUSINESS DONE WEEK ENDING MAR. 25. Highest.		Lowest.
Anglo-American	27,	28	..... 28¼	.....	27½
Do. Preferred	48,	49	 54	.....	48¼
Do. Deferred	5½,	6	..... 6⅛	.....	5½
Brazilian Submarine	11½,	11⅝	..... 11½	.....	11 3-16
Cuba	10⅞,	11¼	..... —	.....	—
Do. Preference	17,	18	..... 17½	.....	—
Direct Spanish	1⅝,	2¼	..... —	.....	—
Do. Preference	10½,	11½	 11	.....	—
Direct United States Cable	9⅛,	9⅜	..... 9 13-16	.....	9⅛
Eastern Telegraph	11⅞,	12	 12	.....	11⅞
Do. 6 per Cent. Preference	13½,	14	..... 13⅞	.....	—
Do. 5 per Cent. Debentures, 1899	105,	108	..... 107⅞	.....	106½
Eastern Extension	12¾,	13	 13	.....	12⅝
German Union	9½,	10	..... —	.....	—
Globe Telegraph and Trust	6¾,	6⅞	..... 7 1-16	.....	6¾
Do. Preference	12⅜,	12½	 13	.....	12 11-16
Great Northern	14⅜,	14⅝	..... —	.....	—
Indo-European	31,	32	..... 31⅝	.....	31½
Reuter's	7½,	8	..... —	.....	—
Submarine	180,	190	..... —	.....	—
West India and Panama	⅝,	¾	..... —	.....	—
Do. 1st Preference	7½,	7⅞	..... 7⅞	.....	7⅞
Western Brazilian	6,	6½	..... 6½	.....	6
Western Union 7 per Cent. 1st Mortgage	120,	125	..... —	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	..... —	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅛,	¼	..... ¼	.....	—
Oriental	⅛,	¼	..... —	.....	—
United Telephone	10½,	10⅝	 11	.....	10 11-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	..... 1½	.....	1⅜
Do. (fully paid)	2⅞,	3¼	..... —	.....	—
Hammond Light (£3 15s. paid)	⅛,	¼	 7-16	.....	—
Swan	—	—	..... —	.....	—
Maxim-Weston	3-16,	5-16	..... —	.....	—

MISCELLANEOUS.

Telegraph Construction	33,	34	..... 33⅞	.....	33½
India Rubber, Gutta Percha, and Telegraph Works	20,	21	..... 20 11-16	.....	20½

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NOTES.

NOTICE OF REPAIR.—The cable between Maranham and Para is repaired.

THE ELECTRIC LIGHT IN TOURS.—Advices from France inform us that the town of Tours is about to be lighted by electricity.

THE ELECTRIC LIGHT IN SPAIN.—The next installation of the electric light in Madrid will be laid down in the Theatre de la Princesse.

PRINCE BISMARCK'S BIRTHDAY.—On Tuesday last, in Berlin, the end of the procession was brought up by the men of the Berlin Chemical Factory, carrying electric lights instead of torches.

THE TELEPHONE IN THE PHILLIPINE ISLANDS.—Telephonic communication is about to be established at Jolo (Phillipine Islands) between the outlying forts and residence of the Military Governor.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 20th March amounted to £3,258. The traffic receipts for the week ended 27th March amounted to £3,307.

CORRECTION.—In our report of the last meeting of the German Union Telegraph and Trust Company we stated, by a typical error, that the dividend was some 4 per cent. less than that declared last year. It should have been ¼ per cent.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 27th March were £2,623, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE WEST AFRICAN CABLE.—The Chamber of Deputies, at Lisbon, sanctioned on the 30th ult., the contract concluded by the Government on July 9th last year, for the laying of a cable establishing telegraphic communication with the West Coast of Africa.

ELECTRIC TRAMWAYS IN AMERICA.—The Daft Electric Light Company has shipped to Baltimore a fifty horse-power dynamo, which will be used for generating power for running cars for the Baltimore and Hamden horse-car line, about two and a-half miles in length.

RECKENZAUN'S TRAMCAR.—As will be seen in another column, a trial was made on Tuesday last of Reckenzaun's electric tramcar, on the line of tramway the property of the South London Tramways Company, with satisfactory results. Except in a few matters of minor detail, the trial proved a great success.

THE ELECTRIC LIGHT IN GUATEMALA.—Since the commencement of the year the Government of Guatemala have installed the electric light in that town. Two turbines of 100 horse-power each, established at a distance 4,500 metres (2·79 miles) from the centre of the town, supply the necessary driving power.

THE SOUDAN TELEGRAPHS.—On Tuesday evening the third Air Line Section Telegraph Battalion Royal Engineers received a sudden order to proceed by train immediately to Gravesend, and embark on the "Ghoorka," for Suakim. When the order was received the men were engaged in bidding farewell to their friends in various portions of the town, and men of the Pontoon Troop had to be sent in all directions to apprise them of the intelligence.

THE SS. "DACIA."—The steamship "Dacia," belonging to the India Rubber, Gutta Percha, and Telegraph Works Company, left on the 2nd inst. for Key West, Florida. She is chartered by the International Ocean Telegraph Company, of New York, and has on board some heavy cable for the part renewal of the 1869 Havana-Key West cable. The new cable is of a type specially manufactured to resist the destructive chemical action of the bottom met with off Key West.

THE IMPORTATION OF RUBBER AND GUTTA PERCHA.—In 1884 there were imported into the United Kingdom 198,000 cwts. of caoutchouc, valued at £2,266,870, as against 227,422 cwts., valued at £3,618,276 in the previous year, and 179,907 cwts., valued at £2,729,298 in 1882. Imports of gutta percha are also less in amount, and were as follow :—62,713 cwts., valued at £462,746, in 1884; 63,073 cwts., valued at £468,388, in 1883; and 72,681 cwts., valued at £537,396, in 882.

THE TELEPHONE AND THEFT.—A tramp at Lismany, in Ireland, recently walked off with a coat belonging to one of the *employés* of Mr. Pollok, of Sycamore-hill. Intelligence was at once telephoned from the house to Ballinasloe. Policemen were set to watch the different entrances to that town from Lismany, and in the evening a stranger, who appeared to be carrying something bulky upon his person, was arrested, when the coat described by the telephonic message was found upon him.

MILLAR'S PATENT COVERED RIBBON WIRE.—We are in receipt of some specimens of Millar's patent covered ribbon wire, No.'s 8, 10, 12, 14, and 16, for the coils of dynamos, motors, &c. It is claimed that the ribbon wire, being nearly rectangular in section, may be coiled into a smaller space than round wire, giving thus a higher efficiency ; also that its great flexibility permits of its being coiled up with only a fraction of the strain required for round wire, and that a saving of labour and risk of damaging the insulation is thus arrived at.

THE ELECTRIC LIGHT IN GERMANY.—Although the Edison Company have now obtained a favourable decision against the Swan Company in respect to the use of the filament lamp, they are not without competition in Germany. In a case of interference between Edison and Bernstein the hollow carbon of Bernstein was declared independent of the Edison claim, and Bernstein lamps are now sold in Germany as usual irrespective of any claims of the Edison Company. We understand that the Bernstein Electric Lamp Company are about to commence manufacturing in England.

THE ELECTRIC LIGHT IN BRUSSELS.—The Administration of Posts had proposed to light electrically the offices of the Temple des Augustins, as the heat thrown out by the gas very greatly inconveniences the *employés* there. It appears, however, that for the accommodation of the dynamos and engines it was necessary to obtain the sanction of the Communal authorities for the erection of an annexe, and this sanction has, up to the present moment, been withheld. The electric light will enter largely into the illuminations on the occasion of the birthday of the King of the Belgians on the 9th instant.

ELECTRIC LIGHT AT A SHALE MINE.—Messrs. Young's Paraffin Light and Mineral Oil Company have adopted the electric light at their Newliston mine, near Edinburgh. Two powerful 16-hour arc lamps are used, hoisted on poles 50ft. high, and give a very brilliant light over the whole working space above ground. The dynamo is driven by the workshop engine, and is arranged to slide on its seat so that the belt can be tightened or slackened when running. The work was carried out by Messrs. Henry Bennett and Co., electric light engineers.

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Glasgow, to specification by Mr. Alexander Morton, consulting engineer.

THE SS. "MAGNETA."—We regret that grave doubts are entertained as to the safety of the "Magneta." The vessel left the Thames nearly a month ago on her voyage to Singapore, but has not been seen nor heard of since leaving the Channel. The underwriters on Wednesday were offering 70 per cent. premium on the insurance, which indicates the feeling of a total loss. It is feared that a collision has occurred, both vessels being totally wrecked. We trust that this surmise may prove unfounded, and that even if the vessel be lost the crew may be on board some sailing vessel that as yet has not touched port.

THE TELEPHONE IN FRANCE.—The public are recognising, little by little, the advantages offered by the telephonic system. The number of new subscriptions tendered last week was 32, as against 19 for the previous week. There are now 56 call stations in successful operation in Paris. The municipal council have not yet decided upon the renewal of the agreement with the Société Générale des Téléphones. This agreement will expire on the 1st of next month. The question will probably be brought forward during the extraordinary session about the middle of April. M. Villard will then, we are informed, propose to the council the prorogation of the agreement in order that other arrangements may be entered into with a view to the abolition of monopoly.

UNIVERSAL READING OF TIME.—Mr. Parker-Rhodes has favoured us with his views on the subject of a universal meridian. To accomplish this he proposes to take a line from a centre point between south and north in the east, to meet a similar point in the west, to encircle the earth, and establish a true prime meridian for all scientific routine and international work, under a universal designation of the day of twenty-four hours. Electricity would be the agency to denote the instant to regulate the observatory clocks of the different nations, and by them the railway clocks could be set. There is nothing very new about this proposal. It is an extension of the principle of universal notation and nomenclature, about which so much has been said of late.

THE ELECTRIC LIGHT ON TORPEDO BOATS FOR THE SPANISH GOVERNMENT.—It has been decided to fit the two torpedo boats which are being built at Messrs. Thorneycroft's for the Spanish Government with the electric light, both for search light purposes and for lighting the interior parts of the boats, using the same machine for both circuits. The Anglo-American Brush Electric Light Corporation are supplying for the purpose one of their special slow speed Victoria dynamos, and are fitting the cabins with their Victoria incandescent lamps, in specially designed mountings, which have proved to be suitable for the service on board of several of Her Majesty's ships. The dynamos are to be driven by Messrs. Brotherhood's three-cylinder engines, coupled direct to the dynamos.

ELECTRIC SEARCH LIGHTS FOR OUR GUN BOATS.—The necessity for supplying our war ships with the electric light is now thoroughly recognised, and the furnishing of gun boats with the requisite dynamos and engines is now being rapidly pushed forward. Amongst the latest additions to the list of ships provided with electric search light apparatus are the "Leander," the "Racer," and the "Mariner," each of which has been fitted with a special slow speed Victoria dynamo, manufactured by the Anglo-American Brush Electric Light Corporation. These compact dynamos are coupled to 3-cylinder Brotherhood engines; and, in addition to providing the current for the search lights, some of them are also used to furnish the current for the Victoria incandescent lamps which are used for below-deck illumination.

ELECTRIC LIGHT IN BARNSLEY.—The New Oaks Colliery has been lighted electrically. The installation comprises 150 Muller incandescent lamps. The whole of the surface, including manager's house, offices, engine houses, mechanic and lamp shops, waggon ways, yards, pit bank, screens, loco. shed, coal washers, boiler houses, and brick sheds, including the pit bottoms and principal roads, were lit and gave great satisfaction. Each lamp is controlled separately, switches and safety fuses are inserted into each main branch and lamp circuit. The dynamo machine is driven from the fan engine, and is of a self-regulating type. This is the largest electric light installation that has ever been put into a colliery. It was erected and lighted by the Simplex Electric Light Company, Valley Mills, Eccles, Manchester, under the superintendence of their electrician, Mr. F. F. Bennett. The installation has given unqualified satisfaction.

DEFENCE OF SUAKIM BY MEANS OF THE ELECTRIC LIGHT.—The electric light having been found to be so useful in protecting our troops from surprises, and enabling them to watch the movements of the enemy even on the darkest night, it has been determined to provide the garrison at Suakim with two powerful search light projectors, and the requisite dynamos for generating the feeding current. These will shortly be supplied from the works of the Anglo-American Brush Electric Light Corporation. The work on the Suakim-Berber railway will also have the advantage of an electrical plant for enabling progress to be made with it both by night and by day. Groups of Brush arc lamps, to the number of 32, supplied with current by four Brush dynamos, and connected in circuit by means of insulated cable sheathed with iron wire, have been supplied from the Brush Corporation's works for this purpose. Parson's engines, manufactured by Messrs. Kitson and Co., of the Airedale Foundry, Leeds, will supply the necessary driving power.

PRESENTATION AT THE CITY AND GUILDS OF LONDON INSTITUTE.—On Thursd ay, the 26th ultimo, the day students of the Technical College, Finsbury, presented to Mr. T. Mather, assistant in the Electrical Department, a non-magnetisable silver chronograph on the occasion of his leaving the college to proceed to his new appointment at the Central Institute. The chronograph is keyless, reads to small fractions of a second, and is so arranged that it can be started, stopped in any position, or have both hands brought back to zero as occasion requires. On the outside the monogram T. M. is engraved, while inside the case is the following inscription:—"Presented to T. Mather by the day students of the Technical College, Finsbury, as a mark of their appreciation of his uniform kindness and attention." The presentation took place at an entertainment (the first of its kind) given by some of the students, Professor Ayrton presiding. Professors Armstrong and Perry, the demonstrators, assistants, and staff, together with nearly all the students, attended to do honour to Mr. Mather, and one and all united in wishing him health and prosperity in his new sphere of work.

THE BUDGET—POST OFFICE TELEGRAPHS.—The telegraphs decreased in the Christmas quarter of the past financial year by £5,000, which was exactly what they had increased in the earlier part of the year. The increase is now £15,000. The service has not realised the hopes of the Chancellor of the Exchequer. He anticipated a receipt of £1,800,000, as against £1,745,000 in the year before. But he has only got £1,760,000—an increase of £15,000 on the year before and £40,000 under the estimate. This want of elasticity in the

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telegraph revenue, says the *Daily News*, is due in all likelihood to the competition of telephones to which Mr. Lefevre alluded on Monday night in introducing his Bill for cheapening telegrams. In some ways the telephone is superseding the telegraph, and for many kinds of business communication it will continue to do so. The cheapening of telegraphic communication will encourage its adoption by larger sections of the public as a means of correspondence, and may eventually result in its familiar use by multitudes who still regard the receipt or despatch of a telegram as an exceptional and even alarming event.

THE VAN RYSSELBERGHE SYSTEM IN FRANCE.—Having regard to the alleged breaking off of the negotiations between Messrs. Mourlon and Co., *concessionnaires* of the Van Rysselberghe system of simultaneous telegraphic and telephonic transmission, we notice the following in *L'Etoile Belge* of the 24th ultimo:—In the last issue of *La Lumière Electrique* there is a statement to the effect that many of our contemporaries, and more especially *L'Etoile Belge*, have contradicted the news given by us relative to the rupture of the negotiations between the French Government and M. Van Rysselberghe. We are in a position to state that our information was exact in all its details, and it it is with some surprise that we find ourselves contradicted. We confine ourselves (says *L'Etoile Belge*) to replying that if we have ventured to question the accuracy of the assertions of a French journal it is only because we have had in our hands the actual correspondence addressed by the Administration of the French Telegraphs to M. Van Rysselberghe, as well as to the holders of his patents, Messrs. Mourlon and Co. That correspondence shows that the negotiations were not for an instant interrupted, and that their conclusion was not delayed by the departure of M. Van Rysselberghe for Spain. By advices from Madrid we are informed that the experiments between Madrid and Burgos, a distance of 250 kilometres (155 miles), have resulted in a perfect success.

THE ABSOLUTE VALUE OF THE SIEMENS MERCURY UNIT, AND THE LENGTH OF THE MERCURY COLUMN EQUIVALENT TO AN OHM.—Mr. H. F. Weber corrects the value obtained in 1876-7; according to this correction the mercury unit is equal to $0{\cdot}9529 \times 10^9 \frac{\text{cm.}}{\text{sec.}}$ (not 0·9550). In 1880 and 1882 the author used the so-called Kirchhoff method of observing the current induced in a second coil on making and breaking the circuit of another coil near it. One coil, A, was laid horizontally on the top of a stone pillar, and the other, B, was supported co-axially just above it on three legs. Both coils were wound on bronze frames, A with 644 turns, and B with 643 turns of wire 1·86 mm. in diameter. The width of the coils was 4·30 and 4·31 cm. respectively, and the radius of the outside layer 17·618 and 17·670 cm. The induced current was measured by means of a galvanometer specially constructed for the purpose. The mean of the experiments of 1880 gave the mercury unit equal to 0·9498 ohm, and the mean for 1882 0·9500 ohm, or about one-quarter per cent. less than the former determinations. The mean of 50 observations with a similar but larger apparatus in 1883 gave the mercury unit equal to $0{\cdot}9496 \times 10^9 \frac{\text{cm.}}{\text{sec.}}$, the highest and lowest values being 0·9509 and 0·9486. Hence, 1 ohm is the resistance at 0° C. of a column of mercury 1 mm.^{2} in section and 105·32 cm. long.

OVERHEAD TELEPHONE WIRES.—A small pamphlet, price one penny, has been issued by Unwin Brothers, 71A, Ludgate-hill, E.C., giving ample and valuable information on the subject of overhead wires. From it we quote the following:—"A Select Committee of the House of Commons is now investigating the subject of overhead wires; but Select Committees are slow and not sure, and those who desire to check the ever-growing nuisance and danger of those wires must not relax their vigilance. One of the chief offenders, the United Telephone Company, not deterred by its failure in 1884, is to the front again with a Bill which may be properly described as 'a Bill to relieve the United Telephone Company from the necessity of paying for the rights which it acquires over other people's property.' Railway and other companies have to pay for all the rights and easements they take over private property; but this company is to have them gratis. Its main object is, of course, to get the widest possible powers for increasing and multiplying its overhead wires. And this is just the thing which it must not be allowed to have. For these two things are quite certain: that overhead wires in towns are a source of great danger, increasing as the number and weight of wires increase; and that telephone wires can be carried underground without any danger and without any loss of working power. The only possible objection to taking them underground is the larger preliminary expense; and it is simply to save themselves this expense, and, at the same time, to escape the necessity of purchasing consents, that the company is promoting this Bill."

VALUES OF THE E.M.F. OF A DANIELL CELL.—Dr. Von Waltenhofen, with a cell in which the zinc was immersed in sulphuric acid diluted in the proportion of 1 of acid to 15 of water, has found the value D = 1·088 volt. The values which are given in old text books are all less than this. Amongst these are the values found by Müller and by Poggendorff, which are expressed in arbitrary units; but, recalculated in absolute units, they come out 0·971 and 0·922 respectively. The next group of values were determined in absolute measure, but the determinations were made by Ohm's method, which, owing to polarisation, would lead to too small a value. They are—

Von Beetz	D = 0·936	volt.
„	D = 0·887	„
J. Regnauld	D = 1·016	„
Buff	D = 1·054	„
Bosscha	D = 1·026	„

The author's determinations of the E.M.F. of the Daniell cell were the first which were made by Poggendorff's second compensation method, and also the first in which Siemens' original resistance apparatus was used. H. F. Weber found the value D = 1·0954 volt, on the assumption that one Siemens unit equals 0·956 ohm. Recalculating this value on the basis of the Congress ohm, which is equal to 1·06 Siemens' unit (or 1 S. U. = 0·943 ohm), we find D = 1·080 volt. Reynier has found D = 1·079 volt, and Alder Wright the same value. It is, however, to be noted that the last three experimenters used a solution of sulphate of zinc in the zinc cell. Kittler has found the E.M.F. of a gravity form of Daniell without partition higher than that of a cell with a partition, 1·195 volt in the former case and 1·111 volt in the latter. The author's value, 1·088 volt, was arrived at from experiments with nine different cells, the internal resistance of which varied from 0·38 S. U. to 4·1 S. U.—*Zeitschrift für Elektrotechnik.*

THE NEW TARIFF.—The *Pall Mall Gazette* remarks that the reason why the charge for addresses has not been introduced before is that the telegraph officials had maintained that the increased trouble of delivery caused by inadequate addresses more than runs away with all the profit gained by curtailing the number of words sent. Mr. Shaw-Lefevre calculates that

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40 per cent. of the telegrams now sent for one shilling will, in future, go for sixpence. There will be an immediate increase of business of 30 per cent. The average receipt for telegrams, which is now 1s. 1d., will in future be 10d. The average cost of transmission will be reduced from 10d. to 8¾d., leaving a margin of 1¼d. profit on each telegram, which will yield a net profit of £180,000, as against a profit of £440,000 in the year 1881, £322,000 in 1882-4, and £225,000 in the current year. At present twenty-four million private telegrams are sent inland every year, and in future it is expected that there will be more than 30 millions. The profit will not pay much more than 1½ per cent. on the capital invested in the State telegraphs. *The Times* thinks that :—In itself it appears almost absurd that the Post Office should insist on being paid for the information without which it could not perform the most essential part of its own work. Naturally it must be the business of the Office, when it accepts the commission, to instruct its subordinates at its own cost how and where they are to execute it. In any case, if the Department repudiates the obligation and tries to shift it on the sender of the message, it incurs a manifest peril of perplexing its people and exposing itself and them to the odium of tardiness and unpunctuality. The most it can in fairness claim is that, while it continues to transmit the recipient's address unpaid, it shall be esteemed at liberty to prune at its discretion particulars of description unnecessary, in the judgment of its clerks, for the safe and prompt arrival of the missive at its destination.

A New Industry: Rubber Shoddy.—Stimulated by the enormous growth of the india rubber industry in the United States, a new article, called "rubber shoddy," of which little is known on this side of the water, is being manufactured in the States, and deserves particular attention. It is produced from " old rubber boots and shoes," which, by a mechanical process, have the fibre (cotton and wool) and other impurities removed. From this state (powdered) the rubber shoddy is devulcanised (desulphurised) by steam heat, and is brought back as nearly as possible to the natural state of crude rubber. Any one not conversant with this article will be astonished to learn to what magnitude the use of it has extended. "Old rubber boots and shoes" have become a regular mercantile article, and are quoted in the journals the same as crude india rubber. The price fluctuates according to the supply and demand, varying from 3d. to 6d. per lb. It is estimated that from 12,000,000 to 15,000,000lbs. are collected annually in the United States, and are used up entirely in the manufacture of rubber shoddy, which in turn is consumed in connection with crude rubber in the production of india rubber goods. But for the substitution of this material, the value of crude rubber would necessarily increase considerably, as can be seen by the foregoing figures. The proportion as to its admixture, of course, depends wholly on the kind of goods it is intended for, and can readily be ascertained by experimenting. For coarser grades of work as high as 75 per cent. is being used, causing an immense saving, the value of shoddy being only about one-tenth of that of crude rubber. The rubber shoddy made by the improved process is superior to any rubber substitute, because it retains the characteristic properties of india rubber. It is thereby adapted to being treated for vulcanisation in the same manner as crude rubber by all processes hitherto employed.—*I. R. and G. P. Trades Journal.*

The American Patent Laws.—The following decisions were arrived at on the 3rd ult. in America :—(1) When an applicant seeks to overthrow a patent granted to one who, though junior in date of conception, has yet shown diligence in filing his application and reducing his invention to practice, the former must show entire freedom from laches, and doubts should be resolved in favour of the patentee. (2) It is not enough for a party to show that he was experimenting in the direction of the invention, but he must have matured his conception so that it can be materialised into an operative device. The conception which the law recognises is not that of the result to be attained, but that of the means to produce such result. (3) The specification of an application for an alleged pioneer invention is addressed to those skilled in the art as it existed before the making of the particular invention therein referred to, and is not to be supplemented and aided by knowledge of events transpiring at a subsequent period, or derived from another's invention of the same thing. (4) An occasional accidental operation of a device, varying from its usual operation, and which is at war with the principle upon which it was designed to act, is not a sound basis for a claim as an inventor to a device capable of uniformly producing similar effects. (5) The declaration of an interference is made on the assumption that the application or patent put in interference covers an operative device, but it by no means follows that such presumption is conclusive; the question of operativeness may be raised and considered in determining the question of priority. (6) The controlling issue in this contest is, in howsoever many claims or subordinate issues it may find expression, a speaking telephone. The inventor of an art and apparatus for transmitting articulate speech cannot be defeated or put under tribute by those who claim to have invented certain constituent elements, but who certainly never produced the completed invention—a speaking telephone. Bell is adjudged the prior inventor of all the issues save D and No. 1, and upon these latter two, priority is awarded to Edison.

Life of Electric Cables Sheathed in Lead.—The following is an account of some tests made the 19th Dec., 1884, by Professors Weber and Wurstemberger, upon a Berthoud-Borel electric cable, supplied by the Kinetic Engineering Company, and laid underground at Cortaillod in September, 1880. This cable, one of the first manufactured under the Berthoud-Borel process, is composed of twelve conductors, formed each of a copper wire nine-tenths of a millimetre in diameter. The cable is protected by a single sheathing of lead. The length of the cable is about 360 yards. It is placed in a trench dug along the margin of the Lake of Neuchâtel, in ground partly marshy and partly gravelly. On account of its position on the border of a lake, whose level is variable, part of the cable is sometimes under and sometimes above the water, and during the winter the ground is frequently covered with ice. In examination the cable was first exposed by digging a wide trench so as to judge of the state of preservation of the lead sheathing. The coating of gas tar which had been applied at the time the cable was laid, in order to protect the lead, completely fulfilled its object. The lead showed no trace of alteration, and on scratching off the thin coating of gas tar which remained adhering to the lead the metal was found intact and in perfect condition. The result of the tests showed that the capacity of a conductor for a kilometre of length = 0·086 microfarad; and the insulation per kilometre gave a mean of 6,026 megohms. The results obtained on the same cable on 5th May, 1883, by Drs. Kleiner, Schneebeli, and Wietlisbach, of Zurich, were :—Capacity = 0·090 microfarad and 3,700 megohms insulation. In comparing these results with those obtained on 19th December, 1884, on the same cable, the insulation appears to have augmented. This probably arises from the fact that a year ago, after certain changes had been made in the signalling instruments, for which the cable was used, a small piece was cut off the cable,

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and the opportunity was taken of placing a sleeve filled with paraffin on the extremity of the cable. The copper wires emerging from the paraffin now have a higher insulation on account of the better protection of the ends.

PROPOSED UNIT FOR GAUGING THE COMMERCIAL VALUE OF DYNAMO MACHINES.—We have recently received a communication from Messrs Thompson, Dowsing, and Rew, upon the subject of a rough and ready method of comparing the value of various dynamos on the assumption that all are equally efficient, and to thus enable the purchaser, by a simple calculation, to arrive at the cheapest machine suited to his purpose. The existing method of dividing the output expressed in watts by the value in pounds sterling $\left(\frac{\text{watts}}{£}\right)$ is not altogether satisfactory, inasmuch as the factor of speed is omitted. Undoubtedly any increase of speed must also mean increase in wear and tear both at bearings and commutator, which, after all, are the only wearable parts. It has been proposed, therefore, by this firm that a fictitious life should be apportioned in each case, bearing a direct relation to the speed, and determined by a sliding rate of depreciation. The standard of depreciation might be taken at 10 per cent. for a speed of 1,000 revolutions per minute, and would be proportionately more or less according to the speed. The life of a machine would then simply represent the dividend of the fraction $\frac{100}{\text{rate of depreciation}}$, or in other words, accepting the given rate of depreciation, the owner would in that time have repaid his machine. A depreciation charge of 10 per cent., at 1,000 revolutions, would therefore mean $\frac{100}{10} = 10$ years, of 15 per cent. at 1,500 revolutions $\frac{100}{15} = 6{\cdot}66$ years, and so on. This factor would of course be entirely arbitrary, and only intended to give a relative value. The expression would then stand $\frac{\text{watts} \times \text{years}}{£}$, that is, so many watt years per £ sterling, or so many commercial units. The writers inform us that these units are not intended to represent any absolute quality, and have themselves anticipated criticism in this respect. They think that some makers may object to a universal comparison in respect to the performance of their machines. That some machines would spark more than others, and that consequently the speed would be no criterion of their life; but in reply to this they affirm that the quality is only nominal, and as in the case of a steam engine, different makers will give more or less efficient results.

THE ALEXANDRA PALACE—ELECTRICAL FEATURES.—The Alexandra Palace, under new management, was formally opened on Tuesday last. The principal attraction provided by the new caterers would seem to be an International Exhibition, but it will be some time before the exhibits are fully arranged. The whole place bears an unfinished appearance, and, although we can quite understand the reasons which induced the management to make every effort to take advantage of the Easter holidays, it is to be regretted that a postponement was not both possible and convenient. The electrical exhibits are at present of the most meagre description. Messrs. Shaw and Connolly, of Alexandra Works, Oldham-road, Manchester, show a great variety of insulated electrical wires and cables, including some main leads of enormous size covered with anti-capillary cotton, and a new insulating compound, superadded upon india rubber, which has recently given excellent results; some kinds of the cotton-covered ribbon leads; and a number of others of large sectional area which are similarly treated in regard to their insulation. To one thing, now in its experimental stage, we must accord unqualified praise. The electric light installation—in reality, a combination of four installations—promises to draw large and appreciative crowds to the North London Eden, and to be eminently satisfactory from a scientific, as well as from a commercial, point of view. The installation has been carried out by the Gülcher Electric Light and Power Company, and consists of sixty-two 2,000 candle-power and five 3,000 candle-power arc lamps, and about 300 incandescent of 5, 10, and 20 candle-power, distributed as follows:—Forty-four arcs of 2,000 candle-power and one of 3,000 candle-power are used for the lighting of the main building, and four lamps of 3,000 candle-power are placed on each tower for the illumination of the grounds. The concert room is lighted by eight arc lamps of 2,000 candle-power, and two clusters of incandescent lamps. The orchestra in the conservatory is lighted by 140 incandescent lamps of varying candle-power placed in flowers and fountains. The fountain in the Winter Garden is lighted by forty 20 candle-power incandescent lamps, in ornamental glass shades, placed so that an artistic effect may be produced. The Forestry Exhibition is lighted by three 2,000 candle-power lamps placed inside the hall, and one 2,000 candle-power lamp outside, for the illumination of the entrance. The Grove and Japanese Gardens are lighted with 14 lamps of 2,000 candle power placed on poles; and the refreshment bar and band stand are lighted with about 100 incandescent lamps, placed in clusters and singly, with coloured glass shades, suspended from the roof. The installation is driven for both the Hall and Forestry by five No. 4 and one No. 2 Gülcher low-tension dynamos, and the motive power is obtained from a Robey semi-portable compound engine of 30 horse-power (nominal) capable of indicating 100 horse-power, by Messrs. Robey and Co., of Lincoln. The dynamos are coupled together by means of the Gülcher improved exchange switch, enabling any dynamo to be cut out of circuit whilst it is running, and another machine switched on without stopping the lights. In the dynamo house the switch-board, safety cut-outs, &c., are placed; and from the arrangement of the lamps—said to be only practicable with the Gülcher system—any arc lamp in the Palace or grounds may be extinguished or lighted from this board. The incandescent and arc lamps being run from the same machine constitutes one of the great advantages of the Gülcher system. In the Grove and Japanese Garden there are two No. 4 Gülcher low-tension dynamos, driven by two 10 horse-power Ransome portable engines. Leather bands are used throughout the installation. Wrought-iron pulleys for driving the dynamos have been adopted as being the lightest and strongest pulleys in the market. The Bungalow Orchestra in the conservatory is a novel feature. At its base are cavernous recesses, dripping wells, pools, and mossy streams, with miniature water falls; the ponds are studded with water lilies, the electric light and water combinations producing marvellous effects. The floor of the orchestra is supported by these cavernous structures, and surrounded by a rustic rail and fringe of exotic plants, ferns, and mosses. The thatched roof is supported by eight gigantic palm trees, which show fruit, illuminated by electric light. The stems of trees and caves are decorated with creepers, vines, and grapes, studded with innumerable electric lights, the grapes and fruits themselves forming illuminations, the whole producing a refreshing and picturesque effect, which may be pronounced a *coup d'oeil* such as one would expect to have presented in fairyland.

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ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 369.)

The Mechanical Forces and their Potential Energy.

The expression for the magnetic energy T may be conveniently put into another remarkable form, thus: By (50), $\Sigma F\mu h = -\Sigma F\mu F$; then by (48) and (51) we obtain

$$\left.\begin{aligned} T &= \Sigma h\mu h/8\pi - \Sigma F\mu F/8\pi, \\ &= T_0 - M, \text{ say} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad (53)$$

Here the magnetic energy T is expressed as the difference of two quantities T_0 and M, of which the first is constant, being the maximum value of T. Short circuit the magnet by an infinitely permeable skin, there will be then no induction outside the skin, and T will be the greatest possible consistent with not altering the interior permeability μ and impressed force h. But it will not in general be as great as T_0. This requires there to be no polar force, so that h at any place can produce the full induction μh. But if we imagine every element of volume surrounded by an infinitely permeable skin, T becomes T_0. Should the magnet be uniformly magnetised, and of uniform permeability, it is sufficient to coat the outer surface with an infinitely permeable skin to increase T to T_0, and in other cases no skin is needed.

For the same reason as before given for T, T_0 and M are both necessarily positive. The quantity M is the same as what Sir W. Thomson calls the "mechanical value" of the magnetic system, or the amount of work that would have to be done against repulsions to build up the intrinsic magnet if it were given in the state of infinitely slender filaments, magnetised parallel to their lengths, placed infinitely widely apart. Or, reversing the operations, imagine the intrinsic magnet to be divided into infinitely slender filaments parallel to the lines of intrinsic magnetisation, and the filaments cut up into short straight pieces (though infinitely long compared with their diameters). Then if the elementary parts thus defined be infinitely widely separated from one another, and from all matter susceptible to induced magnetisation, the work done during the separation by the polar forces would amount to M. But I am unable to verify the statement that M may be either positive or negative ("Electrostatics and Magnetism," Art 731, end of p. 565). The form $\Sigma F\mu F/8\pi$ (not given in the paper quoted) shows that it must be always positive. The following are the principal forms:—

$$\left.\begin{aligned} M = T_0 - T &= \Sigma h\mu h/8\pi - \Sigma H\mu H/8\pi = \Sigma F\mu F/8\pi = \tfrac{1}{2}\Sigma\Omega_1\rho_1 \\ &= \tfrac{1}{2}\Sigma\Omega_1\rho = \Sigma F F_1/8\pi = -\tfrac{1}{2}\Sigma I F_1 = -\tfrac{1}{2}\Sigma I_1 F \end{aligned}\right\} \quad (54)$$

to understand which, it is necessary to say that $I_1 = \mu h/4\pi$ is the intensity of intrinsic magnetisation, and I the actual, the sum of the intrinsic and the induced; F_1 the polar force of the intrinsic, and F the actual polar force; ρ_1 the density of free intrinsic magnetism, and ρ the actual density, Ω_1 the potential of F_1 and Ω of F, and lastly $H = h + F$. For the intrinsic magnetisation we have

$$F_1 = -\nabla\Omega_1; \quad 4\pi\rho_1 = \text{div.}F_1 = -4\pi\text{div.}I_1.$$

Similarly, if the number $_2$ refer to the induced magnetisation, we have

$$F_2 = -\nabla\Omega_2; \quad 4\pi\rho_2 = \text{div.}F_2 = -4\pi\text{div.}I_2.$$

Lastly, $F = F_1 + F_2$, $\Omega = \Omega_1 + \Omega_2$; $\rho = \rho_1 + \rho_2$; $I = I_1 + I_2$.

The connection between the induced and intrinsic magnetisations is

$$I_2 = (\mu - 1)(F_1 + F_2)/4\pi = (\mu - 1)F/4\pi,$$

which makes the induction B to be

$$B = F + 4\pi I_1 + 4\pi I_2 = \mu(F + 4\pi I_1/\mu) = \mu(F + h) = \mu H.$$

The various forms in (54) are got by application of the elementary potential property

$$\Sigma f\mu f = \Sigma p\,\text{div.}\mu f.$$

through all space, f being any "polar" force, whose potential is p, with the assistance of the various relations following (54). The forms in the first line of (54) in terms of forces are the most important.

Now return to the subject from the impressed force point of view. (Our language may be suggestive of our believing magnetic induction to be a purely static state, but such a conclusion is not meant to be conveyed). We suppose there to be impressed magnetic force in the intrinsic magnet, of strength h at any place, which is always present. The impressed forces try to do as much work as they can. They have in any configuration of the system (referring to the external arrangement of magnetisable matter) already done the amount T magnetically, in setting up the state of induction B, which $= \mu H$ everywhere, H being the magnetic force as ordinarily understood outside the intrinsic magnet, including inductively magnetised matter, and the same with the impressed force h added, where there is h, that is, in the intrinsic magnet, which is of course inductively magnetised as well, unless its permeability should be unity. The impressed forces take advantage of all displacements of the system to do more work, if possible. If parts of the system be free to move, move they will, in such a manner as to let the impressed forces do more work, and increase T. The generalised "force," assisting a displacement dx is expressed by

$$\frac{dT}{dx}, \text{ or, } -\frac{dM}{dx};$$

since, T_0 being constant, any increase in T is accompanied by an equal decrease in M.

Any increase of permeability increases the induction and T, unless there be counteracting decrease elsewhere. A sphere of soft iron has no tendency to move anyway when placed in a perfectly uniform field of magnetic force. T is the same for any position of the sphere. But if the field be not uniform it will move so as to increase T. Any small piece of matter inductively magnetised will move in the direction of fastest increase in the square of the force of the field if its permeability be greater than that of the medium in which it moves; and in the direction of fastest decrease when its permeability is less. This is irrespective of the direction of the force. Thus iron moves to, and bismuth from, either magnet pole, and in certain positions they may move straight across the lines of force. This also happens when a wire conveying an electric current attracts iron, the motion being across the lines of force. (This is not a case of intrinsic magnetic force, but the principle is the same.)

Imagine a uniformly intrinsically magnetised magnet to be wholly surrounded by imaginary impermeable matter to begin with. There is no induction anywhere, and $T = 0$. Let outside the magnet there be matter of all degrees of permeability with no retentiveness, and divisible as much as we please, all floating in the standard medium of unit permeability. If we remove some of the impermeable matter from the surface of the magnet, the impressed forces immediately act, and some induction comes out into the surrounding space; and with it there are mechanical stresses set up, which, if yielded to by the matter, assisted by suitable guidance if required, will have the effect of bringing the most permeable matter to and driving the least permeable matter away from the magnet. All the while the impressed forces h are working, increasing T the magnetic energy, and equivalently reducing M the "mechanical value," which was T_0 its greatest value at starting; all the while doing an equal amount of work mechanically, viz., on the matter set in motion, which we may conveniently dispose of by frictional resistance. In the end, supposing we have infinitely permeable matter to surround the magnet with, the whole work done by the impressed forces will be $2T_0$, half magnetically, half mechanically. The final magnetic energy is T_0, the mechanical value, or potential energy, *nil*. The distribution of T as it rises in value from *nil* to T_0 becomes ultimately confined to the magnet alone. For in the final state, the magnet is short-circuited by the infinitely permeable skin. It is only necessary for the ends of the lines of impressed force to be connected by infinitely permeable matter, and this is most simply done by the skin. To obtain the magnetic energy T_0 that is left locked up in the magnet the impressed force must be removed; then, the equations of induction show that T_0 of heat is generated by the induced currents accompanying the subsidence of the induction.

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Regarding the before given definition of the mechanical value, notice that the more slender a filament (longitudinally magnetised) is, the less important is the effect of the polar force on the induction inside, which differs little from μh, except near the ends, μh being the maximum induction h can produce itself. Thus by slitting up the magnet into filaments as described, and separating them infinitely, we have a final state in which the impressed forces have done infinitely nearly the full amount of work they can do, the same amount as if the magnet, without any slitting and separation, were short-circuited, if it be uniformly magnetised.

When work is done by external agency against the mechanical forces, as in drawing soft iron away from a magnet, we reduce T by the same amount. There is, during the motion, magnetic current in the magnet opposed to the impressed force, and the work done against h is twice the decrease in T. Half of this is accounted for by the magnetic energy returned to the magnet (becoming latent, as it were), the other half by the work done mechanically in drawing away the soft iron.

2M might be called the potential energy of the impressed forces in any configuration, being at a maximum $2T_0$ when the forces are prevented from working by an impermeable skin, and zero when short-circuited (with necessary modifications for irregular distributions of h). There are so many senses in which the energy of a magnet may be understood that it is necessary to be precise in stating one's meaning. Therefore, I repeat that by the magnetic energy I always mean the quantity T, which has the value $H\mu H/8\pi$ (or $\frac{1}{2}$ force × induction $/4\pi$) per unit volume, both in the magnet and without (and also when there are electric currents, only then it will not be the magnetic energy of the magnet alone), the intrinsic force, where there is any, to be included in the reckoning of H the magnetic force. We are thereby enabled to make use of electro magnetic ideas without bringing in the hypothetical Ampèrean currents. The inclusion of h in the magnetic force, making $B = \mu H$ always, is specially useful in simplifying both ideas and formulæ, without loss of generality. The theory of magnetism is quite difficult enough already (owing to imperfect retentiveness and variable permeability) without additional gratuitous difficulties.

To return to the mechanical forces set up by a magnet. There is a very important reservation to be made when considering the forces and the variation in the value of T as they are yielded to. The motion must be sufficiently slow to not appreciably alter the force by electric currents set up. That is, the variation of T the magnetic energy (of the magnet) does not ever give exactly the value of the generalised force, and in rapid motions it may be something very different.

For distinctness, consider a round bar magnet (intrinsic) and a round cylinder of soft iron moving in a line with its axis. As the soft iron moves, the induction increases or decreases, both in the magnet and the soft iron, according as it approaches or recedes from the magnet. From the symmetry, the lines of induced E.M.F. are circles about their common axis, and as they are conductors there are currents set up in both (there are also similar circular currents in the dielectric, but not involving waste of energy); their directions are such as to retard the increase of induction on approach, and retard the decrease on recession; hence the attraction of the magnet and soft iron is reduced as they approach, and increased as they recede from one another. More work must be done externally against the attraction in drawing away the soft iron than is done by the magnet in the reverse motion. The difference is accounted for fully, according to the laws of induction, by the heat of the indnced currents. This will be greatest in the magnet itself, less in the soft iron, and a very little in surrounding conductors. This effect has nothing to do with any lagging or retardation of magnetisation in the soft iron, which, if there be any, requires separate reckoning, but is of the same nature as the resistance to the motion of a (practically) unmagnetisable conductor in the magnetic field. Substitute a cylinder of copper for the soft iron; there is no appreciable force now when the cylinder is very slowly moved, as there was no appreciable departure from the normal attraction of the magnet for the soft iron when it was very slowly moved; in both cases the currents set up by rapid motions waste energy, as heat in the magnet and in the soft iron or copper respectively, and this waste must be externally accounted for. Or, supposing the magnet to draw the soft iron from rest at a certain distance, the kinetic energy communicated to the soft iron mass after it has moved a certain length will be less than the increase of T during the motion, the deficit being wasted by the heat of induced currents.

The following brings into a strong light the connection between intrinsic force and intrinsic magnetisation. Suppose we double the permeability in every part of a magnetic system, how will it affect the magnetic energy? That depends on whether we keep the intrinsic force constant or the intrinsic magnetisation. If we keep the intrinsic force constant, we double the magnetic energy, since we keep the actual force unchanged as well, whilst we double the induction. On the other hand, if we keep the intrinsic magnetisation constant, we halve the magnetic energy; for we halve the force everywhere, whilst keeping the induction unchanged.

Similarly, any increase of permeability outside a magnet increases T and the induction. Also any increase of permeability inside the magnet increases the induction and T provided the intrinsic force at the place is unaltered. T_0 is also increased. But if, whilst increasing the permeability at a place inside a magnet, we keep the intrinsic magnetisation constant, we reduce T.

The conduction current analogue will make this plain. In any system of conduction current kept up by impressed E.M.F., any increase of conductivity outside the seat of impressed force will increase the current, and also the heat generation; the same is true if we increase the conductivity at a place where there is impressed force, if we do not alter the impressed force. But if, whilst, say, doubling the conductivity at a certain place where there is impressed force, we halve the strength of the latter, we decrease the current and the heat generation.

(TO BE CONTINUED.)

ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 391.)

The problem to be solved in designing the field magnets for a dynamo is how to obtain a maximum of useful lines with a minimum of iron and copper, for it is the number of lines running across from the polar surfaces to the armature which determines the electromotive force developed in the armature coils. The cutting of magnetic lines of force produces in the cutting wires a tendency for electricity to flow, and the current produced by this tendency is inversely proportional to the electrical resistance of the circuit. To find the current, we require, therefore, to know the resistance of the whole circuit (internal as well as external) and the internal E.M.F. Before entering into the question of how the latter can be calculated it will be useful to say a few words about the internal resistance of the dynamo. This consists partly of the resistance proper of the wires through which the current must flow on its way to and from the outer circuit, and partly of a force impeding the flow of current through the armature coils, which, although not of the nature of a resistance proper, can conveniently be represented as such, and is called the "resistance due to self-induction." In practice, this is either neglected altogether or only roughly estimated as a loss of so much per cent. of the total electromotive force, and as we shall be compelled to establish our formulæ without any regard to such secondary matters as the increase of armature resistance by self-induction or the influence of the armature current on the field, which also tends to slightly lower the electromotive force, and is intimately connected with the former; it will be necessary to inquire somewhat more closely into the subject, so as to be able to estimate how great is the probable error which we are forced to introduce into our calculation by neglecting these things, and thus keeping the formulæ simple enough for practical purposes.

The current passing through the coils of the armature, which to fix ideas we will suppose to be a Gramme ring, with brushes set on a horizontal and field magnet poles

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on a vertical diameter, magnetises or tends to magnetise its core, as if it consisted of two semi-circular horseshoe magnets forming a circle with equal and therefore repelling poles in contact. According to our nomenclature the external lines created by the armature current will leave the ring (Fig. 10)on the side of its north pole N_2, and enter it on the side of its south pole S_2. We may call these the lines of the secondary field, and in the figure they leave the ring to the right, and enter into it to the left of the vertical diameter $N_1 S_1$. The lines from the primary field, which are those useful in producing electromotive force, enter the ring above and leave it below the horizontal diameter $S_2 N_2$. If there were no secondary field the number of lines from the primary field passing into or out of the ring would be the same in all the four quadrants, but as there are these secondary lines it is clear that the total number of lines passing into the ring in quadrant I. will be greater than in quadrant II., and similarly the total number passing out of the ring in quadrant III. will be greater than in quadrant IV. The combined field will no longer be symmetrical to the vertical line, $N_1 S_1$, but to get symmetry we must imagine this line tilted into the position $N^1 S^1$. The angle of tilt will be the greater the stronger the secondary field, and the brushes should be placed nearly at right angles to this new line of symmetry. We say nearly at right angles, because through the shifting of the brushes the secondary field has also been shifted, and this has the result of tilting the combined field still a little further. It might perhaps be thought that since the secondary lines enter and leave the ring at the same side, they can have no detrimental effect on the electromotive force, and this is no doubt true as far as these lines alone are concerned. But

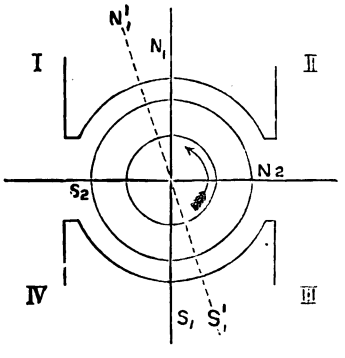

FIG. 10.

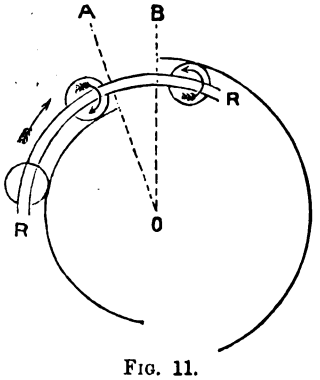

FIG. 11.

it must be remembered that, through the shifting of the brushes it becomes impossible to take full advantage of all the primary lines in each quadrant. Thus to the useful lines in quadrant I. a few opposing lines of quadrant IV. are added, and these have to be deducted from that quadrant, where they would have been useful had the diameter of commutation remained horizontal. The same takes place on the other side, and the general effect is that the shifting of the brushes results in a slight reduction of electromotive force. To minimise the evil it is evidently necessary to so arrange matters that the secondary lines find it difficult to cross the path of the useful primary lines; in other words, we must make the magnetic resistance of the secondary field as great as possible and the magnetising power of the current on the armature core as small as possible. Both these conditions are fulfilled by employing so strong a primary field that all the available magnetic conductivity of the armature core is monopolised by the large number of primary lines. As a necessary consequence of a strong field it follows that comparatively few turns of wire on the armatures suffice to produce the required electromotive force, and thus the magnetising power of these turns is only slight.

Every electric current has inertia—that is to say, it tends to flow on, even after the electromotive force which originally produced it has ceased. The flow continues until the energy contained in the current has been used up in overcoming the resistance of the conductor or other opposing forces, and if the circuit be suddenly broken this energy manifests itself in a spark. The energy of a current is proportional to its field, *i.e.*, to the number of lines surrounding the wire which carries the current. A coil has therefore more energy than a single wire, and if the coil contains an iron core, not otherwise magnetised, the energy is still further increased. This condition that the core should not be otherwise magnetised is of importance. We have seen that a given piece of iron can only accommodate a certain number of lines, and if the core be already saturated with lines from another source, it can offer no accommodation to the lines of our coil, and therefore no increase in their number can take place, in consequence of the presence of a piece of iron already magnetised to saturation. Now, the armature of a dynamo consists of a number of coils arranged all round the circumference, and enclosing an iron core. Each coil may have but one turn, or it may be composed of many turns, and the greater their number the greater will be the inertia of each coil. Any heavy body in motion may be considered as a mechanical analogue to a coil carrying a current, but for our purposes, perhaps the best and simplest illustration is that of a revolving flywheel. If started and then left to itself, the wheel will come gradually to rest in consequence of the opposing force of friction, in the same way as the current gradually ceases in consequence of the electrical resistance of the conductor. If the flywheel belongs to a steam engine with reversing gear, and we were to shut off steam suddenly and a moment afterwards open the valve again, with the valve gear meanwhile set for running the opposite way, we have the mechanical analogue of what happens when a coil, or, rather, the two sections of the commutator belonging to it pass under the brush. Whilst the latter bridges both sections the current flows on by its own inertia, in the same way as the engine keeps moving for a short time after steam is shut off. When the coil has passed the brush it has to carry the current from the foregoing coils, and this current flows in an opposite direction. This corresponds to the reversal of the valve gear and engine. This reversal of current can be represented by the mechanical model shown in Fig. 11. A circular ring, R R (only part of which is shown), is provided with heavy rollers which are made to touch and roll on an inner and outer segment, each somewhat shorter than a semicircle. Whilst rolling on the inner segment each roller revolves clockwise, and when touching the outer circle this movement is reversed. Each roller represents one of the coils of the armature. Its speed of rotation corresponds to the current, and its weight to that portion of the core which is not occupied by primary lines. When the roller passes the line O A, the force which made it rotate has ceased, but the rotation continues until stopped by friction in the journals. When the roller passes the line O B the motion is reversed, and at that moment a certain amount of friction and abrasion must take place, which in our dynamo corresponds to the sparking at the end of the brush. The angle A O B represents that part of the commutator which is covered by the brush. To facilitate the reversal of motion in each roller it will evidently be necessary to make them as light as possible, and if we could introduce somewhere between A and B a force (otherwise than friction) which would start the roller with sufficient speed, it might be made to enter the outer segment without any appreciable friction or abrasion. In our mechanical model this would be difficult, but in the dynamo it is simply done by shifting the brush so far that the coil cuts a few lines even while under the brush, and has a current started in itself a moment before it emerges from under it. These few lines are of course lost for the production of electromotive force, but the sacrifice is amply repaid by absolute freedom from sparking. The above also explains why the position of least sparking is always a little ahead of the position of maximum E.M.F. As already stated, the reduction in E.M.F. here explained can conveniently be expressed as the product of current and the so-called resistance due to self-induction. Several attempts have been made by various scientists to determine this resistance experimentally, the method being to revolve the armature in air whilst sending a current through it, and computing the increase of resistance from the difference of potential at the two brushes and the current. To eliminate the influence of the field of

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the earth the direction of the current is reversed, and the means of the readings are taken. The author has himself tried this method, and after a great deal of care and trouble to exclude sources of error he arrived at the absurd result that in an armature designed for 50 volts not less than from 20 to 35 volts was required to overcome the resistance of self-induction. Evidently there must have been something wrong in the method, and on a little consideration it is easy to see where the fault lies. When revolving an armature in air, say between the centres of a lathe, its core is not traversed by any other lines of force than those belonging to the armature current, and is therefore entirely at the disposal of these secondary lines. As a natural consequence a far larger number of secondary lines is created than would be the case were the armature held in the tight grip of a strong primary field. Experiments made with an armature revolving in air are consequently quite valueless for practical purposes. The only way known to the author in which this question can be investigated is by separately exciting the field of a dynamo machine, and measuring the electromotive force created in the armature—first, when no current is taken from it, and, secondly, when currents are allowed to flow. We obtain thus the static and the dynamic electromotive force, and the difference between them (which difference naturally varies with the current) is the loss of E.M.F. due to the shifting of the combined (primary and secondary) field, and also to self-induction. From a number of experiments the author has found that the loss of electromotive force in modern machines rarely exceeds 5 per cent. of the total electromotive force, and generally averages between 3 and 5 per cent. If we now allow an average loss of 4 per cent. when designing a dynamo, the probable error will be within 3 or 4 per cent., which is a very satisfactory degree of accuracy, especially if we consider that through our as yet imperfect knowledge of the magnetic properties of different brands of iron much more serious errors are likely to creep into our calculations. In the following we shall therefore asssume that an allowance has been made for the secondary lines and for self-induction, and that otherwise these slight disturbing influences need not further be considered.

(TO BE CONTINUED.)

THE INTERNATIONAL SOCIETY OF ELECTRICIANS.

(FROM OUR SPECIAL CORRESPONDENT.)

(CONTINUED FROM PAGE 413.)

In continuing our notice of this Exhibition we must again put on record our surprise that the public attended in such numbers. The crush in the evening was very great, and barricades had to be erected. There is no doubt that wherever the electric light is exhibited in anything like perfection it proves very attractive. A feature worthy of consideration by our educators was the lecture explanations given by many of the exhibitors during the Exhibition to the attentive crowd that gathered around to listen, the professors from the schools and colleges taking their pupils and explaining to them the apparatus shown. One of the most interesting exhibits was that of Planté, who exhibited his apparatus for showing the similarity between globe lightning and electricity. The experiment was very attractive. A description of this will be found on p. 366 of *The Electrician*, Aug. 30, 1884. We may, however, briefly refer to it: "If a condenser, with very thin mica plate, be connected by its two armatures with the electrodes of a secondary battery of 800 couples, the condenser can be pierced, owing to the high tension of the current, and as under these conditions the quantity of current is far greater than with a source of static electricity, the effect is not confined to the production of a crackling spark; a small incandescent globule is formed, owing to the fusion of the matter of the condenser itself, and this globe moves slowly at the surface, following the points where the insulating plate which separates the armatures offers less resistance, and describing a most capriciously sinuous course" (Fig. 1.)

The experiment can be made to last for one or two minutes; it only ceases when the battery is so far discharged that the globule can no longer be maintained in a molten state between the two armatures. The slow motion of this little globule is accompanied by a strong crackling noise, and when the condenser is made to stick to the surface of a plate of hard caoutchouc a shrill and strident noise is heard, something like

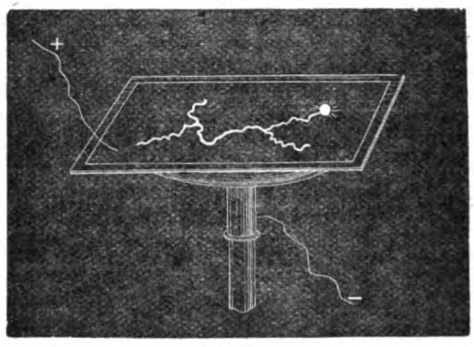


FIG. 1.

that produced by a fast revolving saw when cutting metal. The condenser is at the same time sawn and cut open over the whole course followed by the sparking globule.

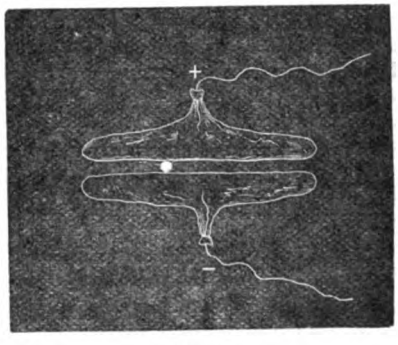
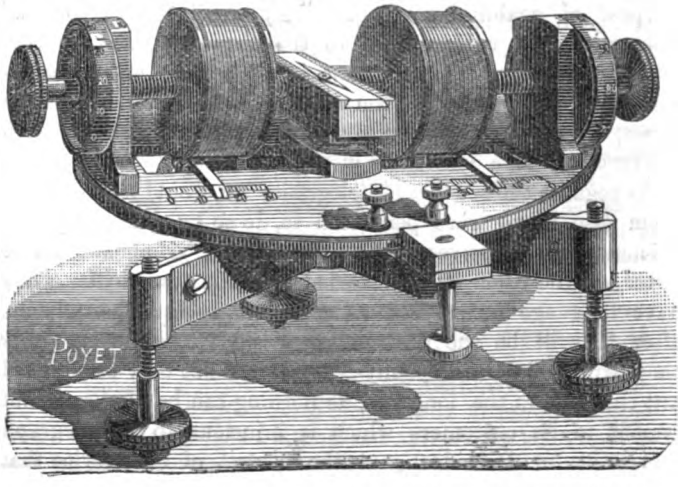


FIG. 2.

Fig. 2 shows a globe of fire travelling between the condenser plates.

The accompanying illustration shows the michrohm-mètre of M. L. Maiché, which was described in our issue of Feb. 28. It consists of a magnetised needle pivoted horizontally, placed between two parallel coils wound with wire of equal resistance. The winding is reversed in each coil, so that the influence of a current passing through the coils upon the needle is neutralised. According to the position of the coils in relation to the magnet, the magnet will remain stationary at zero or at some angle according as one coil exerts more influence than the other. The resistance to be measured is placed in the circuit between the coils, diminishing the current flowing through that coil, and hence the influence upon the needle, which, under these



conditions, moves from its normal position. The equilibrium is restored by adjusting the coil through which the stronger current flows by means of a graduated screw, and the needle may be again brought to zero.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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ANSWER TO CORRESPONDENT.

T. H.—*The matter is fully explained in Dr. Fleming's article. As you say, the rules are very easy to remember and to apply.*

THE NEW TELEGRAPH TARIFF.

If the new tariff for inland telegrams, the chief features of which we were able to announce in our last issue, should be so fortunate as to be ratified by Parliament, there will be good reason to congratulate the Postal Telegraph Department and the general public on a settlement highly satisfactory to both. We say the general public, meaning the general tax-payer, who has no relish for such special burdens as, if certain persons had their way, would be imposed in this case, for the purpose of enabling a comparatively small section to send telegrams at a ruinous cost to the Treasury; and we congratulate the Post Office, because it will now enjoy a reasonable prospect of serving the public on fairly remunerative terms, or at all events on terms that will not saddle it with the certainty of a constantly increasing annual loss.

As regards the senders of telegrams, we would congratulate them also if we were permitted to do so by their noisy and officious representatives in the Press and in Parliament. These latter we know will not be satisfied with the new tariff. They have long ago forewarned us as to that. But their clients, after all, will be the final judges; and we venture to think they will find the halfpenny-a-word rate not only economical but the best in the long run, as nothing can be of permanent benefit to its customers which is injurious to the telegraph service itself. It is clearly to the interest of the service that short telegrams should be the rule; it is none the less to the interest of senders that their telegrams should be short, both on account of the greatly increased speed with which they can be despatched and the saving in the price paid for them.

These are matters which will very soon be discovered without the help of argument. For parliamentary and other advocates of cheap—very cheap—telegraphy arguments we fear will be thrown away. These gentlemen are actuated largely by motives of sentiment; but there is certainly a smack of selfishness about some of them—the selfishness which demands a Government subsidy to further special interests. The sentimental motives deserve a more respectful consideration. Mr. Alderman Lawrence, in July, 1883, gave notice that whenever the new tariff came on for discussion he would move that due recognition should be given to the fact "that much longer addresses are required by artisans and small traders than by merchants and bankers." And in a letter addressed to *The Times* in October of the same year Lord John Manners, an ex-Postmaster-General, argued very warmly for free addresses, mainly because "in proportion as the senders and receivers of telegrams are humble and unknown, will it be necessary for them, in order to secure the delivery of their telegrams, to be liberal in paying for the addresses." Mr. Fawcett, the late Postmaster-General, confessed to a preference for free addresses on similar grounds.

Now we shall not be suspected of any undue leanings in favour of the "merchants and bankers"—or, as we should prefer to call them, the professional senders of telegrams. But we are bound to say that this tenderness for the non-professional senders is quite as foolish and, if possible, rather more mischievous. If a tariff is of proved equity, and economically sound, it would be the height of folly and injustice to destroy these merits for the sake of a class which, though it may be very "humble," is certainly very small. If free addresses, as was shown in the Treasury minute of June 14, '83, would involve an annual loss of nearly £300,000, besides greatly adding to the original outlay, the sacrifice is in any case too great to be made for the problematical convenience of a very small minority. It would be far cheaper and quite as logical to let the "humbler" classes have a special rate all to themselves.

But in reality the supposed grievance is based on a misapprehension. Small tradesmen rarely use the telegraph; and a little reflection will satisfy anybody that small tradesmen will use the telegraph none the more for its being cheaper. Possibly, if local telegraphy—telegraphy within the limits of a town or city—were of much practical utility the case might be different; but we have shown over and over again that telegraphy for local purposes is not, and never can be, a satisfactory means of communication. The small tradesman has little business with the country, and sixpenny telegrams with or without free addresses will not make it for him. As to the artisan, what are the simple facts? His only need for the telegraph—and this, indeed, is a need that will be artificially created, if created at all—is in cases of domestic illness or bereavement. Telegrams of this kind may be, and in fact always are, of the briefest description; and that being the case, there is ample room for the addresses of the humblest and the most unknown.

We believe it to be a delusion to suppose that the community at large is going to be converted into a telegram-sending body when the charges are reduced. Two sixpences go to make a shilling; but for the poorer classes one sixpence is still six times more precious than a postage stamp, and twelve times better than a postcard. And, on the other hand, as regards the general public, the difference between sixpence and a shilling is not so important as to weigh very seriously when the question of telegram or no telegram is being debated. The users of the telegraph will continue to be a class, or a group of classes, who send telegrams pretty freely now, and who will

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send them more freely still when the cost is lessened. These people will very readily adapt themselves to the new conditions, cutting down the addresses—especially their own—to the smallest dimensions consistent with safe delivery, and the text to the depth of their pockets. The saving, on the whole, will be so immense that the extra charge when a long message cannot be avoided will hardly be noticed.

For our own part we are not concerned to advocate one form of tariff in preference to another, so long as the free addresses are got rid of. They have weighed on the telegraph administration of this country so heavily that a reduction of the tariff has been postponed many years later than it ought to have been, because the existing system has been worked at a loss. In no other country have the addresses been allowed to pass untaxed, and we believe in no other country, consequently, has the minimum charge been maintained so high. The privilege is one that cannot be defended on any grounds whatever; and in actual practice it is grossly abused. It has been stated on several occasions by the crotcheteers of cheap telegraphy that free addresses was one of the boons conferred by the transfer of the telegraphs to the State. This is simply untrue. The companies gave free addresses, just as the State gives them now; but simply because they did not know any better at first, and, when they discovered their mistake, they were disabled from rectifying it by the competition of new companies. Attempts were occasionally made to limit the addresses; but the limitation neither pressed on the public nor relieved the companies. What the State did was to perpetuate a system which had been proved to be vicious, and one which every other state in Europe has absolutely disallowed. The new Postmaster-General has done well to follow their example by placing the English telegraphs on a business footing, which, it may be reasonably hoped, will prove a financial success as well as a public boon.

RECKENZAUN'S ELECTRIC TRAMCAR.

On Tuesday last, the first public trial of this car took place, on the lines of the South London Tramway Company. The object of the trial was to afford the members of the Battersea Vestry an opportunity of judging of the practicability of this system of working tramcars. It will be remembered by our readers* that Reckenzaun's system of propelling cars includes the use of accumulators placed on trays under the seats, and of two motors of specially light construction, placed on bogies under the car. The trays run on rollers, which greatly facilitates the changing of the accumulators, an operation which has to be performed about every two hours, when the car is worked to its full carrying capacity. There are 60 cells arranged in two rows of 30, and connected all in series. The current from these cells is led through a switch of special design, which enables the driver to put either motor into circuit alone, or both in series, or both parallel, thus providing a means for regulating the speed and tractive force according to requirements. All these operations are performed by one lever. The reversing gear is worked by another lever, which is set at the beginning of a run, but not touched during the run unless it be necessary to back on to a siding, and the current can be switched on and off by a third lever, which can also be left on during the whole time of a run. The driver has therefore only the lever for varying the power and the usual brake to look after. It is intended to add an electromagnetic brake, which will automatically come into action when the speed of the car from any cause whatever should reach 15 miles an hour. Each end of the car is provided with the controlling apparatus just described.

The weight of the car is 2½ tons, that of the accumulators 1¼ ton, and the two motors, with reversing and controlling gear, weigh just under 10½cwt. At the trial on Tuesday last, which we witnessed, the car was taken out of the depôt at 3 o'clock, and was run westward along Battersea Park-road, meeting on its way a strong contingent of vestrymen, who were taken on board, filling the car to overflowing. Thus loaded it was run up the heavy hill in Battersea Park-road, and everything went well until, on the return journey, through the shaking loose of a nut between the terminals of two cells, the current was broken, and the car stopped for a few minutes. After making the connection good again, the journey was continued up Victoria-road as far as Chelsea Bridge, and then back to the depôt. Just outside the depôt another mishap occurred, but this time not electrical. On account of a bad facing point being not properly set over the car left the rails. The front bogie was ultimately got back on to the rails by running the car backwarks and forwards over the paving, but owing to a sharp curve at that spot the hind bogie could not be persuaded to take the rails again until a straight piece of road within the shed was reached. Thus the last part of the journey was performed under as unfavourable conditions as could well be imagined, and it speaks well for the power of the Reckenzaun motor and gear that the car could be brought home by its own store of electrical power with the hind wheels bumping over the paving stones. Although the trial did not come off as smoothly as the advocates of electrical propulsion might have desired, it nevertheless proved that the scheme of working a tramcar by accumulators is perfectly feasible and practicable, and we congratulate Mr. Reckenzaun on the success already attained. There are certain matters of detail which will have to be looked after, especially a proper connection between the electrodes of the accumulators to prevent them from being loosened by the jolting of the car; and we would suggest that the lugs of all the thirty cells on one side should be soldered together and not screwed up, or if screwing be necessary that lock nuts should be employed. The accumulators, the motors, and the gear have been supplied and fitted up by the Electric Power Storage Company, of Millwall.

* Vide *Electrician* of 20th Dec., 1884, page 113.

EXPERIMENTS IN INDUCTION AND RETARDATION.

The Director-General of the Royal Bavarian Public Works has made the following report on the tests conducted at Munich recently with the 27-core anti-induction aerial telephone cables supplied by Messrs. W. F. Dennis and Co., on behalf of Messrs. Felten and Guilleaume:—"The tests in question have in every respect given entire satisfaction. Each of the two cables that were tested is 1,300m. long, and is suspended to a separate supporting stand, which is spanned from the chief post office at Munich over the house tops to the hospital at the "Gasteig," and made fast to iron standards at intervals of about 100m. on an average. At each standard a good earth connection is provided, and made to communicate with the exterior lead covering of the two cables. For the purpose of testing the cables for induction and retardation a conducting wire of one of the cables was connected at each end with a telephone apparatus (microphone of the Ader system), and thence conducted to earth. The contiguous wire was connected with a telephone, and the two ends in same manner conducted to earth. The three earth copper wires in the centre of the cable and the unemployed 25 conductors of the cable were left unconnected. There was no trace of induction or retardation by the experiments that were made. By means of the microphone a conversation was conducted in a loud tone on the one wire, but not the least sound could be heard on the other wire, which was directly contiguous. For the purpose of comparing the clearness of tone, the same telephones were first connected with the cable wire, and then, with an open overhead wire of about the same length, but no difference could be discovered in the clearness and distinctness of tone. A cable circuit was next connected with overhead wires, under conditions just as they would be in practice, *i.e.*, the two conductors were provided with one and the same earth connection at the one end, but the other two ends with quite different earth connections, the latter

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being about a kilometre apart. Under these circumstances there was also no trace of induction or retardation—not even when the twenty-five remaining conductors were all connected to earth. The earth wires in tbe cable were next connected to earth without any change being noticed. The two cables in the hospital at Gasteig were then joined together, so as to form one single cable 2,600m. long, both ends of which were in the chief post office. On repeating the experiments as described above, a conversation being conducted in a loud tone on the one conductor with the microphone, there were only disjointed and totally unintelligible sounds audible on the immmediately contiguous wire, so faint and low that they could never cause any interference with the working of a telephone. As regards the retardation, there was a diversity of opinion among those present; while some believed they noticed the tone was a little dull, others were unable to notice anything of the kind. On no account could this retardation interfere with the telephonic service. The transfer of sounds from one wire to another, however faint, was further sensibly reduced when one of the conductors, instead of being connected to the earth at the chief post office building (a water pipe), was provided by the intersection of an overhead wire one kilometre long, with an entirely different earth connection. There was then no difference as regards the clearness of tone discernible, whether the remaining conductors and earth wires were connected to earth or not. There are at present 12 conductors of one of the cables working to our entire satisfaction."

ON A PECULIAR BEHAVIOUR OF GLOW-LAMPS when raised to High Incandescence.*

BY WILLIAM HENRY PREECE, F.R.S.

1. During my recent visit to America (October, 1884) Mr. Edison showed me a very striking experiment with glow-lamps, the principle of which he had not threshed out, although he had attempted to apply it practically to the regulation of the current flowing in electric light circuits.

If *abc* be the incandescent filament of a glow-lamp, *de* a thin narrow platinum plate fixed between the limbs of a filament with an independent wire connection *ee'* sealed in the glass globe, then, if a galvanometer, G, be connected between *a*, the positive electrode, and *e*, a derived current will be observed to pass through G, and through the rarefied space *ec* when the main current is increased to a certain strength, and the filament reaches a certain degree of incandescence. The strength of this derived current will increase with the increased brilliancy of the glowing filament. Mr. Edison made for me several lamps of different forms and character to enable me to investigate the phenomenon more carefully in England, and I have the pleasure of submitting the results of those experiments to the society.

2. I used 60 Faure-Sellon-Volckmar cells freshly and fully charged up at each series of experiments. The current through the filament was measured by a specially constituted and calibrated Ayrton and Perry direct-reading spring ammeter. The galvanometer in the shunt circuit was a sensitive tangent galvanometer of the Post Office pattern. The current through the filament was regulated by varying the number of cells. The current and electromotive force through the shunt *ae* were calculated by the following method:—The resistance of the galvanometer G was 1070 ohms, and a variable resistance, R, was inserted in its circuit. When the current from a standard Daniell cell (1·07 volt) is sent through the galvanometer, we get a tangent reading, *d*, which, since $\frac{1{\cdot}07}{1070} = {\cdot}001$, is the deflection, or tangent reading corresponding to 1 milliampere of current. The deflection (d_1) given by the shunt current was first read without any resistance being inserted.

Hence

$$C = \frac{d_1}{d} \text{ milliamperes.}$$

Resistance was then added and a second reading, d_2, taken; then the resistance r of the shunt is obtained from the formula

$$r = R \cdot \frac{d_2}{d_1 - d_2} - G.$$

The electromotive force producing the current is

$$E = Cr.$$

The shunt circuit includes the rarefied space *ec*, and it is the resistance of this space that we desire to know.

All the observations were simultaneously made by different observers. While one observed the behaviour of the lamp, another read the current flowing through the filament, a third read the currents in the shunt, a fourth varied the electromotive force, and a fifth recorded the results. The electromotive force of the cells was carefully measured before and after the experiments. No photometric measurements were attempted.

3. *Experiment* 1.—The connections were made as shown in Fig. 1. The lamp (No. 4) was a short (75 mm.) filament lamp, with a platinum plate 30 mm. long and 5 mm. broad.

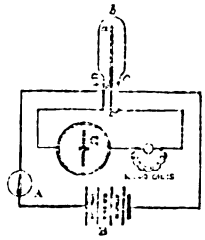

Fig. 1.

The variation of the current and the increase in the resistance of the filament towards the end of the experiment, together with the behaviour of the shunt, are very noticeable. It is quite clear that when the electromotive force attained 82 volts a critical point was reached. From that point the current in the filament remained very steady, but the resistance gradually increased. The shunt increased in resistance enormously, and the current through it diminished, although the electromotive force increased very largely. It is remarkable how steady the electromotive force in the shunt remained until the critical point was reached, when it suddenly increased, and only reached that of the main current at the point of rupture of the filament. Again the current, which steadily increased until the critical point was reached, then diminished, indicating a considerable increase in the resistance of the rarefied space *ec*. In one subsequent experiment, after the critical point was reached, no current could be obtained through the shunt.

The direction of the current is shown in Fig. 1.

Towards the end of the experiment, when the characteristic diffused blue effect in the globe was very marked, a bright arc was observed to be playing about the bottom of the limb at *c*, and it was quite clear that a bridge of conducting material was formed between *e* and *c*, which, together with the galvanometer, made a shunt to the filament.

This experiment was repeated upon different lamps, and the results were so similar that it is not necessary to reproduce the observations.

In all cases an intimate connection was observed between the blue effect and the appearance of the shunt current.

4. One of Mr. Edison's assistants showed me in Philadelphia that while the effect was very perceptible when the connections were made as shown in Fig. 1, *a* being in connection with the positive and *e* with the negative pole, no shunt current, or a very slight one, could be observed when the direction of the current was reversed. I did not find this invariably the case. One lamp (No. 8) only—a long filament lamp (150 mm. long)—which gave a marked shunt current and the blue effect when the connections were made as in Fig. 1 failed to give any current or blue effect when the current was reversed within the limits of the electromotive force at my command. Doubtless I should have got both effects if I could have raised the electromotive force. In all cases, however, the effects appeared sooner and were more marked when the connections were as shown in Fig. 1 than when the direction of the current was reversed. The effect of placing the galvanometer between *e* and *c* was the same as reversing the current.

5. As the effect might be due in some way to the material of the conducting plate (*de*) inserted between the limbs of the filament, Mr. Edison made for me lamps with copper, iron and carbon plates.

Experiments 2, 3, and 4 were then made, the connections being the same as Fig. 1.

No marked difference was thus observable.

If we examine the shunt current when the faint blue tinge appeared, it was: with carbon, 3·42; with iron, 5·85; and with copper, 3·80 milliamperes.

6. It might be affected by the extent of surface of the metal plate, therefore lamps were made with a plate of fine wire, and also of a very broad surface, but no difference was observable between these and the normal plate used.

7. Lamp No. 9 was made with a double platinum plate, thus:—

Fig. 2.

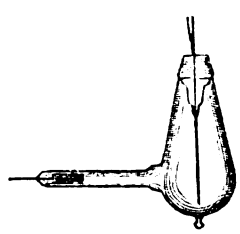

Fig. 3.

The experiment No. 5 shows that no perceptible difference was observable.

8. Although the maximum effect was produced by Mr. Edison when the plate was fixed between the limbs, he obtained a current when it was fixed in any part of the rarefied space. If the effect was due primarily to the Crookes effect, or to the projection of molecules from the carbon filament on to the metal plate, since this bombardmen takes place in right lines

* A paper read before the Society of Telegraph Engineers and Electricians.

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EXPERIMENT 1.

Filament. Volts.	Amperes.	Calculated Resistance (hot).	Shunt. Calculated E.M.F.	Current in Milli-amperes.	Resistance in Ohms.	Remarks.
		ohms.	volts.			
44·40	0·7	63·4				
46·62	0·75	62·17	...	...	...	Normal incandescence, viz., 8 candles.
48·84	0·81	60·30				
51·06	0·86	59·37				
53·28	0·91	58·55	14·7	0·30	49,000	
55·50	0·97	57·21	...	...	...	Diffused blue effect in globe appeared.
57·72	1·02	56·60	16·6	1·15	14,500	
59·94	1·08	55·50	16·2	1·80	9,000	
62·16	1·13	55·01	13·5	2·70	5,000	
64·38	1·20	53·66	11·95	3·85	3,000	
66·60	1·24	53·71	7·45	5·25	1,400	Blue effect brilliant.
68·82	1·24	55·51	10·00	5·00	2,000	
71·04	1·30	54·65	9·10	6·00	1,300	
73·26	1·35	54·28	6·50	5·00	1,300	
75·48	1·35	55·92	9·35	5·50	1,700	
77·70	1·41	55·12	9·60	6·00	1.600	
79·92	1·47	54·38	9·80	7·00	1,400	
82·14	1·60	51·34	} critical point			Deflection too unsteady for observation. Blue effect very brilliant.
84·36	1·60	52·74				
86·58	1·53	56·59				
88·80	1·56	57·00	50·6	2·20	23,000	
91·02	1·53	59·30	62·5	2·50	25,000	
93·24	1·57	59·40	61·0	3·20	19,000	
95·46	1·60	59·51	95·0	3·80	25,000	
97·68	...	...	...	...	...	Filament broke. Interior of globe and faces of plate blackened.

EXPERIMENT 2.—Carbon Centre (single).

80	0·50	160·0				
84	·57	147·4	...	0·98		
88	·60	146·7	5·44	0·54	99,000	
92	·65	141·6	4·76	1·22	39,000	
96	·70	137·1	27·7	2·20	12,600	
100	·74	135·1	25·4	3·42	7,420	Blue tinge appeared.
104	·79	131·7	21·4	4·88	4,380	
108	·83	130·1	17·5	7·32	2,390	
88	0·60	146·7	08·23	0·46	179,000	Reversed the current through the filament and repeated experiments. Blue tinge appeared.
92	·65	141·6	04 86	0·93	52,300	
96	·70	137·1	26·0	1·76	14,800	
100	·74	135·1	21·1	2·93	7,190	
104	·79	131·7	19·1	4·45	4,300	
108	·83	130·1	17·5	7·32	2,390	

EXPERIMENT 3.—Iron Centre (single).

80	0·50	160·0				
90	·57	157·9				
96	·62	154·8	...	0·25		
100	·66	151·5	...	0·49		
110	·77	142·9	31·4	2·05	15,300	
120	·87	137·9	19·8	5·85	3,380	Faint blue.
90	0·57	157·9	...	0·09	..	Reversed the current through the filament and repeated experiments.
100	·66	151·5	...	0·49		
110	·77	142·9	27·3	1·95	14,000	
120	·87	137·9	20·0	5·61	3,560	Faint blue.

EXPERIMENT 4.—Copper Centre (single).

80	0·57	140·4	...	0·048		
90	·67	134·3	39·2	1·12	35,000	
100	·79	126·6	19·0	3·80	5,000	Faint blue.
110	·90	122·2	... needle hard over		...	Strong blue.
90	0·67	134·3	29·9	0·88	34,000	Reversed the current through the filament and repeated experiments.
100	·79	126·6	17·2	3·32	5,190	Faint blue.
110	·90	122·2	... needle hard over		...	Strong blue

EXPERIMENT 5.—No. 9 Lamp (double platinum).

Filament. Volts.	Amperes.	Calculated resistance (hot).	Shunt. Calculated E.M.F. Left.	Right.	Current in Milliamperes. Left.	Right.	Ohms. Left.	Right.
		ohms.	volts.	volts.				
80	0·56	142·9	5·46	5·46	0·39	0·39	140,000	140,000
84	·60	140·0	3·8	3·8	0·83	0·83	45,700	45,700
88	·65	135·4	24·5	24·5	1·56	1·56	15,700	15,700
90	·68	132·4	20·5	20·5	2·05	2 05	10,000	10,000
94	·72	130·6	16·2	16·2	3·27	3·27	4,950	4,950
100	·79	126·6	15·4	15·4	5·85	5·85	2,630	2,630*
110	·92	119·6			Doubtful.			

* Remark.—Slight blue tinge perceptible.

EXPERIMENT 6.—No. 5 Lamp.

Filament. Volts.	Amperes.	Calculated Resistance (hot).	Shunt. Calculated E.M.F.	Current in Milli-amperes.	Resistance in Ohms.	Remarks.
		ohms.	volts.			
50	...	...	...	...	...	$a+$, $c-$, Fig. 1.
60						
70	0·55	127·3				
80	0·65	123·1				
84	0·70	120·0				
86	0·73	117·8				
88	0·75	117·3				
90	0·77	116·9				
92	0·80	115·0				
94	0·82	114·6				
96	0·85	113·0		No current.		
98	0·87	112·6	...	...	...	Blue effect visible in bulb.
100	0·89	112·4				
102	0·93	109·7				
104	0·96	108·3				[none in tube.
106	0·99	107·1	...	...	...	Blue effect strong in bulb;
108	1·01	106·9				
110	1·05	104·7				

Re-commenced Experiment with 100 volts.

100	0·89	112·4	...	...	...	$a+$, $c-$, Fig. 1.
102	0·93	109·7				
104	0·96	108·3	...	·049		
106	0·99	107·1	...	·049		
108	1·01	106·9	...	...	...	Blue effect entering tube.
110	1·05	104·7	...	·073		
112	1·07	104·7	...	·146		
114	1·11	102·7	...	·195		
116	1·14	101·8	...	·24		
118	1·18	100·0	11.3	·39	29,000?	Deflection too low to enable resist. to be meas.
120	1·22	98·36	10·9	·49	22,300	

EXPERIMENT 7.—No. 6 Lamp (long filament).

76						
80	0·57	140·3				
84	0·60	140·0				
88	0·65	135·4				
92	0·71	129·6				
96	0·75	128·0				
100	0·80	125·0	...	...	...	Faint blue in globe.
104	0·84	123·8	..	·049	Deflections too low to enable resistance to be measured.	
108	0·89	121·3	...	·085		
112	0·94	119·1	...	·10		Blue in globe very marked.
116	0·99	117·2	...	·073		
120	1·06	113·2	...	·20		Bulb hot, tube cool.

EXPERIMENT 8.—No. 7 Lamp.

80	0·56	142·9				
90	0·66	136·4				
100	0·77	129·9	...	...	...	Blue effect in globe visible.
102	0·79	129·1				
104	0·82	126·8				
106	0·84	126·2				
108	0·86	125·6				
110	0·89	123·6				
112	0·91	123·1				
114	0·94	121·3				
116	0·98	118·4				
118	1·00	118·0				
120	1·02	117·7				

No current evident in either section.

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we ought to have obtained effects when these lines were projected on the plate, but no effects when they could not strike the plate. Several lamps were made, which are shown in the annexed sketches.

9. The metal plate was taken from between the limbs of the filament, and placed at the end of a tube which had a portion of the filament exposed to the plate.

After the first portion of Experiment No. 6 I reversed the current through the filament. Returned to 90 volts, and repeated the experiments. Filament current readings the same as before, and also the blue effects. At 108 volts a slight blue effect was noticed in the open end of the tube.

Doubtless, if I could have increased the electromotive force, the results would have been more marked; but they were sufficient to show that the effects were evident, even though the rarefied space were greatly extended, as in the case of the tube attached to No. 5 lamp.

10. The tube was constructed so that no portion of the filament was opposed by right lines to the metal plate (Fig. 4). (Experiment 7.)

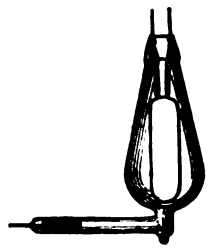

FIG. 4.

11. A lamp was constructed with three branches at right angles to each other, as shown in Fig. 5, and each metal plate taken in succession, but no results were obtained. (Experiment 8.)

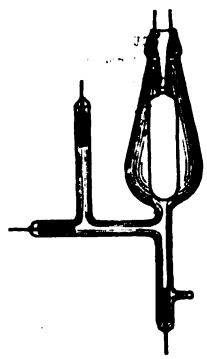

FIG. 5.

12. Professors Liveing and Dewar (*Proc.* Roy. Soc., March 9, 1882), observed a "sort of flame" during high incandescence, showing by its spectrum the presence of carbonic oxide. It was strongest about the junction of the carbon thread and the positive electrode. It was, according to them, the glow of the positive pole attending a discharge in rarefied gas.

It is a common thing with glow-lamps which have the heels of the filament close together to have an arc forming across when the electromotive force at the terminals is too high. Hence in recent lamps requiring 100 volts, Mr. Swan has considerably increased the distance between the electrodes. Moreover, whenever the incandescence of the filament is raised beyond a certain limit the interior of the glass envelope is blackened by a layer of carbon, which has been deposited by a Crookes bombardment effect. When the carbon filament is fixed on copper electrodes, the interior of the glass sometimes becomes coated with copper as well as with carbon, and the line between the two is perfectly marked, showing that the bombardment takes place in right lines. Experiment 1 shows how very high the electromotive force can be carried, if it be steadily and rapidly increased, before the filament is broken; but practice shows that when once the blue effect appears, destruction is only a question of time. Hence the blue effect is an indication of the advent of disintegration, and a very useful warning of danger ahead.

13. Now it is clear that we have a combination of the phenomena above described in the Edison effect. A continuous bridge of molecules is formed between the junction of the carbon filament and the metal plates inserted between its heels. They are found deposited on the metal plate. A shunt is thus formed whose resistance is measurable, and a definite current passes. This shunt is formed just where the negative metallic connection joins the heel of the carbon filament, as we should expect from the investigations of Mr. Crookes. The current is, however, weak and variable, and it is scarcely reliable enough to be useful for practical purposes, as was hoped by its discoverer. When the critical point is reached the blue glow and flame seem to pervade the whole bulb, and the arc-like effect, instead of playing about the heel, surrounds apparently the whole filament. The result is that the current passes through the galvanometer and through the rarefied space. This is clearly shown in Experiment 1.

14. It is quite clear that the critical point is reached when the filament commences to be disintegrated by the projection of its molecules from its surface. It is here that the resistance of the filament commences to increase, and the law of radiation and light emission (*Proc.* Roy. Soc., No. 229, 1884) commences to be departed from, as was shown by me in a paper read before the British Association at the Montreal meeting.*

15. It is very evident that this Edison effect is due to the formation of an arc between the carbon filament and the metal plate fixed in the vacuous bulb; that this arc is due to the projection of the carbon particles in right lines across the vacuous space; and that it makes its appearance earlier, and is more strongly marked, when the connections are as shown in Fig. 1 than when they are reversed, because, as Mr. Crookes has pointed out, the projection proceeds from the negative to the positive pole, and it would commence at the point of least resistance. Its presence is detrimental to the life of the lamp, and as its appearance is contemporaneous with the blue effect, the latter is a warning of the approach of the critical point, and a sure indication that the electromotive force is dangerously high. It is also clear that as the Edison effect is only evident when we are "among the breakers," it is not available for practically regulating the conditions of electric light currents as its ingenious discoverer originally proposed.

SIXPENNY TELEGRAMS BILL.

In the House of Commons on Monday last, Mr. SHAW-LEFEVRE, on resuming the adjourned debate for leave to introduce this Bill, said:—Hon. members will probably recollect that two years ago a resolution of my hon. friend the member for Glasgow was carried against the Government, calling for a reduction of the minimum charge for telegrams from 1s. to 6d. In view of this resolution the Government promised to introduce a new tariff with a sixpenny minimum. In the interval, preparations have been made for the increase of business which is expected from the reduction, and about half a million has been spent on increasing the plant and adding to the wires on some of the principal lines, and it has been decided that the new tariff shall come into force on the 1st of August next. My lamented predecessor, Mr. Fawcett, who took the greatest possible interest in this subject, had not come to any determination as to what the new tariff should be, and he left no indication what his views were on the subject, but he had appointed a departmental committee to report on the financial effect of various tariffs which had been suggested. In the interval, since the resolution I refer to, I regret to say that the financial position of the telegraph service has not only not improved, but it is very decidedly worse than it was. The profits on telegrams, which for some years had been very low, gradually rose till the year 1881; but hon. members who have examined the parliamentary account for the year 1883-4 recently laid before the House under the Telegraph Act, will see, on comparing it with the account for 1880-1, that in the former year there was a surplus profit of £325,000 out of which to pay the interest on the capital invested in the telegraphs, and in last year a deficit of £19,600. The comparison, however, is scarcely a fair one, as the account for the last year includes the sum of £175,000 expended in adding to the plant for the purpose of introducing the 6d. telegram, and is therefore capital expenditure. Both accounts also contain a considerable expenditure, which is necessary year by year for extending the wires to new places, and which is, strictly speaking, capital expenditure. If the annual accounts were made out on strictly commercial principles, it would appear that the profit in 1881 was £440,000, in 1883-4 £322,000, and for the current year ending on the 31st of March next it will be about £255,000, which would pay interest at the rate of not quite 2½ per. cent. on the capital invested by the State in the telegraphs. This reduction of profit since 1881 is due mainly to the increase of salaries made two and three years ago to the telegraphists and other officers in the service which were pressed on the Government by many members of the House, and which, in the opinion of my predecessor, were fully justified; in part also by the increased cost of maintenance during the last two or three years, owing to the wearing out of posts and other plant taken over by the department from the telegraph companies. The House will see, therefore, that the margin of profit at the present time is not large and does not pay full interest on the capital invested. I should also point out that owing to the depression of trade the receipts have been very stationary the last two or three years, and that we are now subject to the competition of the telephone. The next point I have to bring under the notice of the House is the effect of the present tariff for telegrams, and how far it leads to unnecessary and unprofitable labour to the department in the transmission of superfluous and unnecessary words. Under the Act of 1868 no charge can be made by the department for addresses, and for words in the text the tariff is 1s. for 20 words, and 3d. for every five yards after. There is therefore no inducement whatever to senders of telegrams to compress their addresses within reasonable limits or to compress or limit the words of their text provided

* In this paper I pointed out from experimental data that the light emitted by a glow lamp varied apparently as the sixth power of the current. I verified this law, not only by subsequent experiments of my own, but, which is much more satisfactory, by experiments of others. Professor Kittler, of Darmstadt, and Captain Abney made, independently of each other, most careful and exhaustive measurements in this direction. I tabulated and traced them out in curves. They fully confirm the law that $L = kC^6$, but within limits, and that these limits embrace the ordinary range of a glow lamp when used for artificial illumination. As long as the resistance and the current vary uniformly together the law holds good; but as the state of incandescence is increased, a point is reached, varying with each kind of lamp, when the resistance ceases to diminish at the same rate, and eventually to increase. When this occurs the law is departed from, and the light emitted increases much faster than the sixth power of the current. The filament speedily breaks. The point of departure from the law indicates a point when a change of state occurs in the carbon filament. Disintegration probably sets in. This point ought to be determined for each kind of lamp, and it should never be allowed to be reached, for it is from this point that decay commences and rupture follows.

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they do not exceed 20. The average number of words in addresses is a little over 11, of which four are devoted to the name and address of the sender and seven to that of the addressee, and the average number of words in the text is 17—making a total average of 28. We differ in our method of charge from nearly every other country in Europe; almost without exception their tariffs are based on payment per word, including the addresses, and with some low minimum charge; the result is that there is every inducement to compress the words and limit the length of addresses and text. In foreign telegrams sent from this country, where the charge is a purely word rate, the average number of words used in addresses is five; in Germany it is only four. Under our system there is no inducement whatever to limit the addresses; many firms habitually stamp their telegrams with the full name of their firm where one word would be quite sufficient. I received myself a few days ago a telegram in which 26 words were used in the address and where six would have amply sufficed. It is the same with the text of the message. Very few people take any pains to limit their words within 20, and a great many purposely fill up to 20 because they like to have their money's worth. The result is that in a very large proportion of telegrams there are superfluous words, and the plant of the department and the time of staff are occupied in transmitting these unnecessary words without any benefit to the Government or to the public. If the tariff were such as to give inducement to compress the words and to cut off what is unnecessary it is certain that the same plant and staff would transmit a greatly increased amount of business. The present annual number of inland private telegrams is 24 millions, and the average receipt from them is 13d., showing how few exceed 20 words. A very careful estimate has been made of the cost of transmitting them, and we believe that 10d. may fairly be taken as the average cost of transmitting a telegram, without taking into account interest on the plant. It will be obvious to the House that if we were to reduce the rates all round by one-half, retaining free address, our receipts for the present telegrams would be reduced by one half, or about £50,000, and our expenses would remain the same, while the increased business due to the reduction would be carried on at a loss. If we were to retain free addresses and to allow five words in the text, it has been calculated that, assuming an increase of 30 per cent. in the number of telegrams, the difference to the department, as compared with the present tariff, would be £264,000, or considerably more than the whole of the present margin of profit on the commercial account. This tariff also would not be very favourable to the public, for while it would allow any number of words in the address, the words in the text would be very limited, and it would not be open to senders to economise their words in the address in order to add them to the message itself. The fact is that if only a small total number of words can be allowed for the minimum charge, it is the interest of the senders of telegrams that they should be allowed to economise words in the address in order to add to the text of the message. It becomes, therefore, the interest both of the public and of the Government that inducement should be given to limit the words of the address, and the only way of effecting this is to charge ratably for the words used both in the address and in the message. After careful consideration of all the various tariffs which have been suggested, I have come to the conclusion that, of those which are within financial possibility, the best both for the senders of telegrams and for the Department—the one which will bring in the best return while giving the greatest latitude to the sender—is the simple charge of 1d. for every two words, with a minimum charge of 6d. We believe that, under this tariff, the average number of words used in the address will be reduced from eleven to five, of which one word only will be the average of the sender's address and four of the address of the receiver. In a very large number of cases it will be unnecessary to insert any address for the sender. The text will show clearly from whom it comes; in nine cases out of ten one word will suffice, and in the same way, though not in the same proportion, there will be great economies in the address of the receiver. There will also be great economies in the text of messages; a careful examination of great numbers of telegrams has convinced the officers of the Telegraph Department that 30 or 40 per cent. of the telegrams now sent for 1s. will in future be compressed so as to be sent for the minimum charge of 6d. Of the new business attracted by this low tariff a very much larger portion will be at the *minimum* rate. It is estimated that there will be an immediate increase of business of 30 per cent. It is thus calculated that the average receipts for telegrams will be reduced from 13d. to 10d., and that the average cost of transmitting them will be reduced from 10d. to 8¾d., leaving a margin of 1¼d. in lieu of 3d. The difference to the Department, therefore, partly in the shape of reduced receipts and partly in increased staff, will be about £180,000, which the House will see will leave us but a very small margin of profit. The tariff I have thus proposed is very much that which was suggested two years ago by a large majority of the principal Chambers of Commerce, and, I think, by the hon. member for Glasgow. The only objection I have heard to it is that it may tell somewhat unequally upon the poorer classes of the community who live in our great towns and whose addresses require fuller description than others. I should be very sorry if this class should not receive full benefit from any change. At present a telegram costing 1s. is a rare luxury to people in this class. I have applied to the telegraph offices in those parts of London and elsewhere where the working classes mainly live, and out of 24,000 telegrams only 167 can be attributed to persons in this class, or less than one-half per cent. These telegrams have been carefully examined; 156 of them were sent for 1s.; of these 71, or nearly one-half, could be compressed without any difficulty and by the exercise of very ordinary intelligence within 12 words including their addresses, so as to come within the minimum charge of 6d. The fact is, that the great bulk of these telegrams are of the simplest character, reporting the death or illness of a member of the family, or reporting the movements of the sender, and require a very few words to tell their tale. I am convinced from a personal examination of these telegrams that the senders of them will derive at least their full share in the benefit which is to result from the tariff I propose, and that the 6d. telegram will be an immense boon to the poorer classes of the community, and bring the telegraph within the reach of large numbers who cannot now afford to send messages. I have in conclusion to say that the measure which I propose will repeal the provisions of the Telegraph Act of 1868, requiring that addresses should be transmitted free of charge, and will enable the Post Office to charge a word rate for addresses as well as for the text of messages. In adopting this tariff, we shall bring our system into harmony with that of every other country in Europe, we shall put ourselves in a position to meet on better terms the competition of the telephones, and we shall be doing the very utmost which the financial position of the telegraph service permits of.

Mr. STUART-WORTLEY entered a protest against the proposal to charge for the address, and expressed a hope that that part of the scheme would not be pressed. He asked whether the shilling rate would be continued side by side with the sixpenny rate.

Dr. CAMERON believed that in diminishing the cost of telegrams there would be a great accession of revenue. He expressed approval of the halfpenny per word rate, and insisted on the importance of maintaining the address of the consignee with sufficient fulness so as to be readily intelligible. On the whole, he thought the scheme very much that which was shadowed forth by the late Postmaster-General some years ago, and, as such, the House and the public could not expect anything better.

Mr TOMLINSON thought that the Post Office had missed a great opportunity in not taking up the telephones and working them on a large scale. The use of the telephone had enormously diminished the receipts from the telegraphs.

Mr. T. P. O'CONNOR expressed dissatisfaction with the scheme as a whole.

Mr. SEXTON thought there was considerable force in the objection that under the new scheme with the addresses charged for senders of telegrams would be placed at a considerable disadvantage as compared with those under the present system. He thought it should be optional on the part of the public whether they should select the shilling rate or the sixpenny rate.

Mr. SHAW-LEFEVRE thought it would not be possible to keep up the two scales of charge together. The receipts from the telegraphs had been very stationary during the last two years, partly owing to the depression of trade and partly from the competition of the telephone. He hoped, however, that by the reduction of the charge which he now proposed, a more favourable return would be obtained.

Leave was then given to bring in the Bill.

On Tuesday the Bill was read a first time, when Lord J. MANNERS gave notice, on the second reading of the Bill, to move an amendment for the purpose of retaining free addresses.

THE COMMITTEE ON OVERHEAD WIRES.

Many of our readers having expressed a desire to have this subject dealt with by us week by week, we, in deference to their wishes, publish the following:—

The Select Committee of the House of Commons, appointed to inquire into the law relating to the control of telephonic, telegraphic, and other wires, has held three sittings under the presidency of Mr. G. W. E. Russell. The Committee has now adjourned until the 16th inst. We append the evidence of the principal witnesses.

On the occasion of the first sitting Mr. ROBERT HUNTER, solicitor to the Post Office, gave evidence with special reference to the relative position and powers of the Post Office and private companies. He said that the rights of the Post Office were defined by Acts of Parliament, the Act of 1868 having transferred the telegraphs to that department, and the Act of 1869 giving the Postmaster-General a monopoly of the telegraphs, but conferring no special powers with regard to the laying of wires. Up to 1878 local road authorities possessed an absolute veto as to the fixing of overhead wires, but in that year another Act was passed, giving the Postmaster-General an appeal against such veto to the magistrates or the County Court, and a further appeal to the Royal Commissioners. At present the Post Office, when desiring to erect an overhead wire in a town, must obtain (1) the consent of the road authority; (2) the consent of the private persons upon whose buildings an attachment is proposed, or, if the line is a pole line, the consent of the occupier of every dwelling house within ten yards of a pole; and (3) besides this, in the country the consent of the persons owning and occupying parks and pleasure grounds along the route. With regard to attachments and the erection of posts within ten yards of a dwelling house, there is apparently no right of appeal from a refusal of a consent. Mr. Hunter offers these suggestions for simplifying the existing system: that there should be an appeal in every case, except as to attachments to private property; that the Postmaster-General should give proper notice of his desire to erect a line, and that all persons who have a *locus standi* under the Act of 1863 to veto or object—whether public authorities or the owners of property affected—should have an opportunity of sending in written ojections, and that the case should then stand referred to some one tribunal having the power to deal with the matter once for all; that this tribunal should be the County Court, which has hitherto disposed of cases in a simple and inexpensive way; that the appeal to the Royal Commissoners should be abolished as unnecessary, and causing delay and expense; and that the provision requiring the consent of the occupier of every house, within ten yards of which a pole is to be erected, should be repealed, or that at least the distance should be reduced; the right of such occupiers to object with other persons interested in property along the route seeming

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to be sufficient protection. With regard to underground wires, Mr. Hunter does not consider any alteration in the law necessary, except as to abolishing the appeal to the Royal Commissioners. Private companies he would place in the same position as the Post Office in the matter of overhead wires. This much as to the Post Office and ordinary telegraph wires.

In the case of telephone wires, Mr. Hunter explains that telephone companies, as licensees of the Post Office, are not entitled to any of the statutory powers which the Postmaster-General possesses as to the erection and maintenance of telegraphs. They cannot interfere with public highways, or carry wires either over or under highways, and their position has been fixed by legal decisions upon several actions against the United Telephone Company. They may not interfere with a highway in order to lay an underground wire in such a way as to cause obstruction to the public, even though such obstruction exists only during the work of laying down the wire, either with or without the consent of the local authority. In towns the road authority is, under various statutes, the owner of the surface of the street, and any interference with such surface is a trespass; and both in town and country remedies are provided for the obstruction of highways within distances varying from 15ft. to 30ft. of the centre, and persons causing an obstruction beyond such distances may be proceeded against by indictment for creating a nuisance. But with regard to overhead wires, it has been laid down in a case by the Wandsworth District Board against the United Telephone Company, respecting a wire across High-street, Putney, that the road authority in a town in whom the streets are vested by Act of Parliament has no veto upon the erection of a wire across a street, provided that the wire is suspended from supports which are not fixed upon the road; that it crosses the road at a height above the ordinary user of the road; and that it does not threaten danger or damage to the public. Road authorities in country districts, where the surface of the roads is not vested in them, have no greater rights than urban authorities; and the position of the telephone companies, therefore, appears to be that they may erect wires across a highway unless they are likely to be dangerous to the public. But, on the other hand, there are some cases in which the soil of a street is vested in a corporation, or some other body or persons, not by virtue of Act of Parliament, but as an ordinary question of property, and in such cases the erection of a wire, apart from the question of danger or nuisance, must be treated as a trespass, and dealt with accordingly. Apart, however, from the general law applicable to telephone wires, several corporations have obtained Acts giving them special powers for regulating these wires. In some of these Acts the corporation is empowered to make bye-laws (to be approved by the Board of Trade) for the inspection, execution, prohibition (except by license), and removal of telephone wires, together with a right to recover penalties against offenders; and in cases where a wire may not be erected without a license, an appeal to a court of summary jurisdiction is given against an unreasonable withholding of assent. Over and above these restrictions upon telephones, the Post Office has the power to practically forbid their erection by refusing the license which every telephone company must obtain, and in so acting is subject to no check except by proceedings in Parliament, but control of that kind is not easily exercised or very effective. This being how the matter stands as to telephones, Mr. Hunter advises that all persons desiring to erect overhead telephone wires should have the same powers as the Post Office in respect to roads; and, further, that licensees of the Post Office, and only such persons, should also have the same rights as the Postmaster-General possesses as to laying down underground wires—both provisions, however, being subject to the condition that the Postmaster-General should have notice of every intended wire and that he should have a veto upon the proposal if he considers that the wire will injure any Post Office wire, or occupy space which he will require for Post Office purposes within a limited time. With regard to electric lighting wires, the Act of 1882 distinctly forbids the laying of wires along, over or across any street or road without the express consent of the local authority, and also gives a right of appeal to a court of summary jurisdiction to any person against an overhead electric wire, even though the consent of the local authority has been obtained.

Mr. GRAVES, engineer to the Post Office, put the cost per mile of underground wires at £368, and pointed out the great difference in mileage between overhead and underground wires, a difference which was altogether in favour of the latter. It was possible to lay a large number of wires in one pipe, which became, practically speaking, a cable, whilst the number of wires possible to be run in an aerial cable was much smaller.

During the proceedings the question was raised and negatived whether the committee should take into consideration the bill promoted by the United Telephone Company.

Mr. J. BOND MORGAN, Managing Director of the United Telephone Company, said his company was formed in 1880 by the union of the Edison and Bell Companies, and by this amalgamation the subscribers to the two companies were connected with one exchange system forming the Metropolitan Telephone Exchange. There were eighteen district exchanges, and 3,447 subscribers, excluding the 300 subscribers to the Stock Exchange. Subscribers to the Metropolitan Exchange paid £20 a year, and 10 per cent. of this amount was required by the Postmaster-General as royalty. Their license from the Post Office was for thirty-one years from January, 1881, and the Postmaster-General reserved power to purchase at the end of 1890, 1897, or 1904, at a price to be settled by arbitration. This license did not allow any written messages to be delivered, and the system was strictly confined to verbal communications. The United Telephone Company, under arrangements now being concluded with district companies, would not itself work any but the Metropolitan Exchange; all others were to be worked by the various district companies holding licenses to use the patents and working under licenses held from the Postmaster-General. Prior to the extended license granted by Mr. Fawcett last year, the extension of the business of the telephone companies had been much hampered, particularly in the connection of towns one with another. This and the limit of radius and the difficulty of getting way-leaves for the running of wires had much hindered the development of business. The whole of the United Company's wires in London (about 5,000 miles in length) were overhouse wires, except in a few places, where they were run in subways. The practice of constructing overhead wires was usual throughout Great Britain and America. The telephone companies had no compulsory powers and did their entire business on sufference. Like the Postmaster-General, they passed their lines over private property without permission; but they did not claim the right to do this, and where they could not meet the views of objectors or obtain formal permissions, they removed the wires. They did not ask the permission of local authorities to cross streets, and were advised that local authorities had no such property in the soil as would entitle them to interfere with wires passing over the streets, unless the wires were placed so near the ground as to interfere with the traffic, or were in a dangerous state. This view had been confirmed by the Court of Appeal in the case tried at the instance of the Wandsworth District Board of Works. The United Company made a point of keeping the wires at such a height above the street as to clear all possible traffic, even a fire escape, as Captain Shaw could prove. The company ordinarily used a 3-strand No. 16 gauge iron wire, weighing about 10lb. to the 100 yards, with a breaking strain of from 700 to 800lb. In some cases a phosphor-bronze wire, very much the same as a hard-drawn copper wire, was used. This was a 2-strand wire, weighing about 2½lb. to the 100 yards, and had a breaking strain of about 250lb. The company also used a good many aerial cables containing from twenty to forty wires, with a 3-strand No. 16 galvanised iron wire as a core. These were suspended upon suitable iron wires, but were quite sufficient to sustain their own weight. During the five years in which the company's overground system had existed in London there had only been three trifling accidents causing injury to persons, and none of these had been caused by the breaking of a wire. The fact that the Company, without any compulsory powers, had been able to construct so many overhead wires showed conclusively that the objection to these wires was not a general one. He was aware that the cost of running wires over houses was much less than the cost of running them on posts along the sides of the streets, and vastly less than the cost of putting them underground. In fact, it would be practically impossible to put the wires underground, and in connection with this question he asked the Committee to consider one very important point. The telephone brought electrical communication to the house or office of every subscriber, and there could be no collection and delivery of telephone communication as of telegrams. The company had therefore to run a separate wire into each subscriber's office; and although a considerable number of wires might start from an exchange in one direction, they began immediately to spread and scatter, and soon separated into ten or a dozen different routes, until finally there were as many routes as there were subscribers. The cost of a single overhouse wire was not more than £2 2s. per mile, and unless there were any exceptional difficulties as to way-leaves, the whole thing would not cost more than £10 a mile. Mr. Graves, engineer-in-chief to the Post Office, put the cost of a single underground line at about £368 a mile, and if a wooden pavement, or asphalte, with concrete, had to be taken up, the cost would be very much larger. In fact the cost of underground wires would be prohibitory, not to speak of the annoyance and inconvenience caused to the public by interruption of the traffic. The telephone was of immense advantage to the public, as was evidenced by the fact that the number of communications by telephone in London exceeded the number of messages sent by telegram. The telephone enabled persons to communicate very much more rapidly than was possible by telegraph, and had this further advantage that half a dozen persons in different places might carry on a conversation together just as if they were in the same room. Now that the limits of radius formerly imposed by the Post Office had been removed, towns could be readily connected. Brighton was in communication with London, and the large mercantile centres in the north were being connected up. This had been done without any adverse effect on the Post Office revenue, which had continued to grow, and at an increasing rate since the introduction of the telephone. Generally speaking, the companies had had little difficulty with provincial local authorities, the individual members of which found the use of the telephone in conducting their business. In the metropolis, owing to the great division of authority, no general regulations had been adopted. There were thirty-eight local authorities in London, and it would be quite impossible to have thirty-eight different sets of regulations, and thirty-eight different sets of inspections. Whatever regulations were made must be uniform. The telephone companies never objected to any reasonable regulations and control by the local authority, consistent with the maintenance of their existing right to pass wires over the streets. They had only objected where the authorities had sought absolute powers to take the wires down. He was of opinion that bye-laws might be framed by the local authorities, sanctioned by the Local Government Board or the Board of Trade, and enforced by a magistrate. The proposal of the Post Office would not, in his opinion, work satisfactorily, as the delays attendant on such a scheme would seriously interfere with business. The companies thought that having regard to the importance of their work and the increasing value of the system to the public, some facilities should be given to them for carrying on their work. With this object the United Telephone Company had introduced a Bill operating in the metropolis and a radius of 100 miles therefrom. The company asked powers to run lines above or under roads, subject to various restrictions. They also asked for power to pass wires over private property upon payment of compensation for any damage done, subject to the wire not being placed within a certain distance of the ground or of the roof of the building, and subject also to a provision requiring the company to remove the wire if the owner required to use the property

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for any purpose with which the continuance of the wire would interfere. The company also asked that limited owners should be at liberty to grant way-leaves during their ownership, reserving to the reversioner full rights of removal. These powers would, in witness's opinion, much facilitate the operations of the telephone companies, and would not prejudice the rights of private owners.

Mr. SPAGNOLETTI, the telegraph engineer of the Great Western Railway Company, expressed his opinion that the telephone system could not have attained its present dimensions but for the convenience of running the wires overhead, and he estimated that such wires, including poles and other appliances, cost only about £70 or £80 a mile, while underground wires would cost nearer £480 a mile. Besides that great cost, the trouble and public inconvenience of breaking up streets would render an underground system quite impracticable; and, on the other hand, the experience gained, and the mechanical improvements made in recent years, enabled engineers to erect overhead wires with perfect safety, and without annoyance to anyone.

Mr. M. HUNTER (re-called) said he had made an analysis of the powers reserved to local authorities by private Acts of Parliament with reference to telephone wires. These provisions might be classified under three heads: First, provisions giving the corporation or local authority an absolute veto upon the erection of wires; second, provisions giving such a veto subject to an appeal to a court of summary jurisdiction; and, third, provisions enabling the local authority to make bye-laws for the prohibition and regulation of telephone wires subject to confirmation by the Board of Trade. In case of disputes the matters were decided in two ways. In one case it was made a judicial matter and went before a magistrate, and in the other it was made a municipal matter, but the corporation could not make an order without the assent of the Board of Trade. There was great objection to the Board of Trade deciding on a Post Office matter. They preferred a reference to a county court judge. They had no particular objection to an appeal to the Railway Commissioners, but thought it would lead to inconvenience and delay. They would have no objection to the appeal being made to the county court judge in the country and the Railway Commissioners in the London district, but in the case of an appeal being made from the country to the latter it was hard to bring the local authorities to London. There had been a few cases in which the Post Office had had to pay compensation for injuries by falling wires during construction, but there had been no compensation cases arising from the falling of wires which had been blown down by the wind.

Mr. J. S. FORBES was called, and, examined by the chairman, said that he was the deputy-chairman of the United Telephone Company. He said he had a great deal to do with the rights of the Post Office and telephone companies, having had litigation with them for a considerable time. They came to a compromise, and by an agreement the United Telephone Company became licensees of the Post Office. The development of telephonic communication had been impeded by the restrictions of the Post Office. Of course the Post Office had bought up at a very high price the telegraph companies, and they considered it their business to protect that business by every means possible. They foresaw that telephonic communication would interfere with their revenues, and telephone companies were tied up by restrictions, and at last the Postmaster-General agreed to give additional facilities to the telephone companies.

But, in spite of that, you have difficulties by reason of the want of legal status?—Yes, we are under great difficulty; in fact, we are only allowed to carry on our operations on sufferance, and that enormously cripples our operations and prevents us getting on as rapidly or effectually as the business requires. I doubt whether we are aware of the enormous extent to which this can be done, and the importance of it in a multiplicity of ways. For instance, one is with reference to fires. The diminution of fires has been traced to the extension of the telephone. I have a wire for my own use, fixed from Victoria Station to Beckenham Station. I live within three miles; there is no telegraphic communication, except from Bromley, and for that I am charged 1s. from London, and sometimes 2s., and sometimes 2s. 6d. for delivery. Well, I found that when I got my telephone to Beckenham a great many people wanted to make use of it. That sort of thing is growing, and there are thousands of merchants and clerks living at Ramsgate and Margate who would make use of the communication. I think that every railway station adjacent to a town ought to be connected with a telephone in the centre of the town. You cannot do that without a legal position, and certain facilities being assured to you outside the caprice of individuals or public bodies. I think that the time has come when the telephone, like other public enterprises of great moment, should have something like compulsory powers given to it having regard to certain interests.

There are other things, besides the difficulties of the Post Office, that you want removed, and the want of legal status. There is the nervousness of the public about overhead wires?—There are a great many people of that sort, and their nervousness is in proportion to their ignorance. There is a theoretical danger, but nothing to justify an impediment to a great public work. Cabs in London, and the parcels vans, and the butchers' carts are a source of danger; but still these things must be kept up.

The telephone cannot be continued beyond West Wickham and Edmonton because the local authorities won't allow wires to pass over their places?—Yes, there is a great deal of that sort of thing, and you are much at the caprice of individuals. We have 4,000 subscribers, and we have multifarious private wires. The question is, is it of sufficient public utility to justify its existence, and can it exist, or ought it to exist at the caprice of individuals? We do not think that it ought. We should therefore prefer to be under the Board of Works rather than under thirty-eight vestries. We should then have uniformity of treatment. The Board of Works would be the best authority for making bye-laws, and there should be an appeal on any matter of vital importance to some outside tribunal in case of serious difference. That appeal should be to a department of state, say the Board of Trade. The utility for a communication between the different railway companies that have their termini in London is very great. We cannot communicate by telegram, because it is too slow and does not answer our purpose. We do it by telephone, and the managers consult with each other as though they were in a room. It would be very useful in removing troops from Chatham or Dover to the north of England, and we could make our arrangements and come to conclusions as to what we were to do, passing the troops on from one company to another in a few minutes, just as though we were sitting in a room; in fact, the uses of the telephone in the future will be very great. There is no reason why every railway station half a mile or three-quarters of a mile distant from a town should not be connected with the centre of the town by telephone, and there are thousands of ways of utilising it at small cost. I use the telephone myself many times when I do not get time to use the telegraph. There are restrictions, owing to the state of the law and to the prejudice of individuals, which we want to remove.

In reply to Sir JAMES M'GAREL HOGG, the witness said that they would be sure to have uniformity of despatch if the controlling authority of the telephone companies was the Board of Works. The railway companies hold their rights from the Postmaster-General, and they are precluded from putting up wires, except with the consent of the Postmaster-General.

By Sir ALEXANDER GORDON: Do you seek the power merely to cross a man's field from two different posts, or do you seek to put a post on a ground or a house?—We should have compulsory power to do both and pay for any damage.

You do not recognise the right of appeal to the owner?—No.

If I have agricultural land, and you put the post in the middle of that field, do you claim the right to go on that crop whenever you think proper?—Yes, subject to payment for the damage.

Supposing I am an astronomer and I want to sweep the horizon with my telescope, what compensation will you give me?—I will put you in telephonic communication with Greenwich as compensation [laughter].

Is the feeling against wires the same as what you called a frivolous feeling against the ventilators?—It is about as sensible, but it is not so focussed.

By Mr. DICKSON: You think that the tenant should give permission to have the wire placed on his house?—Yes; that seems a sufficient protection to the landlord.

Are overhead wires necessary?—I have come to the conclusion that it is absolutely necessary to have overhead wires.

If overhead wires were not used, would it be possible commercially to develop the interest of the telephone?—No. Of course, the telephone costs £20 a year, and that is considered a very heavy payment for the convenience of some persons; but if that argument is to prevail and overhead wires are not to be used, it must cost more than at present.

Do you look forward to a reduction of the price?—I suppose in time, with simplicity of construction and efficiency, that would follow almost as a matter of consequence.

Ought you to have increased facilities for the erection of wires?—Yes; it is in consequence of the difficulties of way-leave that we have to make eighteen points of exchange where a much smaller number would suffice, and that means increased cost. Simplicity gives an efficiency of service, because every time you have a transfer there is a delay and irregularity.

It was said that between 100 and 200 wires were damaged in London in the late snowstorm. Is it your experience that the overhead wires are a source of danger?—You have wires falling, but I suppose the measure of danger is the loss to life or limb as the result, and these cases are marvellously few.

In answer to Mr. GRAY,

The witness said that the telephones would demand a night service, and they hoped to supply that.

By Mr. FIRTH: Are you anxious to have authority to place overhead and underground wires without consent of anybody?—No; I have said that I am willing to submit to an authority, such as the Board of Works.

You want to be enabled to carry your wires over anywhere without the consent of the owner?—Yes—the intervening ground between two necessary centres.

That is a power you have not now?—We are absolutely on sufferance.

Supposing you stretch a wire over a house, and there comes an exceptional snowstorm which causes the wire to break, would you be liable in damages to the person you injured, the snowstorm being possibly considered an "act of God"?—I have not had the advantage of being trained as a lawyer, or practised at the bar; but, still, I understand that an "act of God" would not generally be visited on an individual. If this telephone work is to go on there must be compulsion of a reasonable or rational kind, and that might be defined by the law.

Do you think that legislation should be enacted to give compulsory powers to telephone companies?—Yes. If this is to be a matter of public utility it should be carried out under reasonable conditions, and not be at the caprice of individuals.

By the CHAIRMAN: In case of danger to the occupying tenant would there be compensation to the landlord or to the tenant?—To the tenant if he were injured. I should not like to interfere with the common law. Those affected by the danger should receive the compensation. The going over premises as proposed by the Bill confers no right. The public utility of the telephone is so great that the companies will have to have compulsory powers sooner or later, and I think it would be the readiest and most economical way to recognise the necessities of compulsion which attach to it.

Mr. WINTERBOTHAM was the next witness. His firm were solicitors to the United Telephone Company, and he had personal charge of the evidence in this case. He understood the Telegraph Act of 1863 applied principally to the business of telegraph companies as then carried on. It then consisted of collection between town and town with one public office for the despatch of messages. The bulk of their work was therefore on railways

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and public roads, and their run was longer than for telephonic communication. Therefore, the first thing was to obtain the consent of the railway authorities; and all the powers and regulations were for the purpose of protecting owners of property adjacent to or adjoining the roads in the case of the line running along these roads. There is a power under sec. 21 of the Telegraph Act, 1863, with reference to telegraph companies who pass over private property entirely. If they obtain the consent of the road authority, they may pass the wires over the property adjoining or near to the street, provided that it was not building land or a pleasure ground.

But you draw a distinction between the work that you describe and that of the telephone companies?—The Act hardly applies to the great bulk of telephone companies, whose principal business is to connect and exchange by a house-to-house line at some points not very far distant, going as nearly as possible as the crow flies. We do not use the streets in the ordinary sense of the term, and we have to get the wires over them. We do not use the streets in the way this Act contemplates their being used. Then our lines are being very constantly renewed and others taken away, and then lines are cut up. Assuming that we have got the attachments, our lines are connected very rapidly indeed, and any regulations, such as those provided by the Act of 1863, requiring a change in this would be quite inapplicable. When that Act came into operation it might take twelve months to run a line. First, the road authority's consent has to be obtained, and if they object they go to a County Court judge or a magistrate, from whom they appeal if necessary to the Railway Commissioners. But even assuming the consent of the road authority given, they have to publish notices, serve them upon the owners of property within fifty yards of the road, and advertise in the local papers, and wait twenty-one days for notice of objections, and refer these objections to the Board of Trade. The whole process is one which might be applicable on a traffic line of many miles in length but which would be altogether inapplicable to a short line over a house.

And such a system would be incompatible with the development of telephones?—Yes; we can hardly get on at all. In the country it takes us six or eight months or longer; in towns, when they obtain the consent of the road authority, they may run near the roads without further consent, but they have to give 21 days' notice, even in that case; and that seems to take a month before you can commence. The Post Office do as I do; they would get the necessary permission, and pass over people's houses without the 21 days' notice, and if objection is taken, they would arrange the matter, or try to arrange it, or get it round some other way.

On behalf of the telephone companies how would you sum up what you desire?—I agree with Mr. Forbes in saying that the business is a necessary one, and has become increasingly important, and that such facilities must be given as will enable us to connect subscribers by these wires as speedily as possible. What is necessary for that purpose is a matter on which there may be some difference of opinion, but we are quite agreed as to this—wherever we have permission to erect poles, we should have power to pass over intervening property without asking permission of the owner, subject to paying compensation, should any injury be done.

You limit the payment to injury; do you mean incidental or depreciation of property?—There was a case suggested of a person who wished to observe the stars. I could imagine the wires being thrown across would be a serious injury; but, except in such cases as that I cannot conceive of any injury being done by the passing of a wire over.

You would not pay for the compensation?—We should not pass within a certain distance from the roof, and if he requires it to be removed at any future time we should be bound to remove it, and we should obtain no easement or right by passing over. We should pay compensation if we did any injury—that would be sufficient to protect any public right.

If you paid anything at all in the recognition of right it would be a pepper-corn rent?—Such a recognition should be given, as it would give protection in every case.

You would pay for mere attachment where it was made?—Yes, I think that that ought to be properly made. I would claim the right of passing over property, and I would claim the right subject to restrictions and regulations similar to that of the Postmaster-General on passing along roads or under roads wherever it was feasible. Whether it would be necessary to ask for compulsory powers to make attachments, I am not clear. At the present time facilities have been granted readily in most cases, and the difficulty has chiefly arisen from the fact of passing over property. If we get permission from two persons to erect poles, we have to pass that wire over 100 people, and one of these objecting would prevent that wire passing.

Then you ought to have some compulsory power to override factitious opposition?—I think so. In regard to passing over a public road, any regulations for the purpose of preventing improper erections the telephone company would not only assent to but would be glad to see adopted.

Therefore, you would be liable to the regulations of some public body. Have you any choice of what that public body would be?—Of course, in most towns there is one municipal authority; in London it is not so, but we must have one body to look to in the metropolis instead of 38. The Metropolitan Board is the only general representative body at present. The Chelsea Vestry suggested that Board for this purpose. At any rate, it should be a representative body which should control us. Whatever body you have should control the whole of a town and the suburbs of that town. We want certainty and uniformity. Another point is despatch and rapidity—that is of the greatest importance.

Mr. FIRTH: Do you agree with the St. James's Vestry, that every wire should be registered?—I think that there would be a difficulty in keeping a registry of wires, but every pole is marked in such a way as to show what wires there are. I do not know how the wires could be registered unless they were marked. In practice it would be a little awkward. So far as getting a record of existing wires there would be no difficulty about it.

The Committee adjourned until Thursday, the 16th April.

COMPANIES' MEETINGS.

The Direct Spanish Telegraph Company (Limited).

The twenty-third ordinary general meeting of this Company was held last Monday, at the Cannon-street Hotel, Sir James Anderson in the chair.

Mr. CH. GERHARDI, the manager, read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN said: Before moving the adoption of the report I will, as usual, make such remarks as occur to me concerning matters that the shareholders ought to be cognisant of. The first remarks I will make will be rather against the Company perhaps, at all events they will show you the worst side; then afterwards I shall tell you what, in my opinion, are the prospects of the Company. I begin, then, by saying that since I became a Director of this Company we have found to our regret that the old cable is in such a bad condition that we cannot at present see how much it would take to put it in order or when it will be done. In the first place we have not money sufficient to spend upon any expensive inspection or overhauling of it. In the second place we have not at the present time a ship available. All the ships, owing to the present war, are taken up for telegraph purposes abroad, and nothing but a very expensive ship could now be had. For that reason we could very well afford to wait until another season, by which time I hope we shall have a larger revenue in hand, and one of the Eastern Company's ships will be able to effect the repair, at all events to effect the overhauling. Next, gentlemen, we have lost in our revenue considerably this year, owing to two causes; the first is that there has been cholera in the Mediterranean, which induced the Spaniards to put on quarantine at all the ports, and drive all the commercial men, who are our best customers, away from Marseilles and Barcelona. Next the land lines in Spain have been working very badly. Spain, I am sorry to say, has a deficit in its Budget to such an extent that they have been unable for the last two years to expend any money upon the repairs of telegraphs. The result is unfortunate to us, because the lines are so bad that telegrams are very slow either coming by this Company or by the Eastern Company. Now these are two causes of our present unfortunate position, but there is still another. Some few years ago we adopted what is called the word system, by which merchants can send one word to answer any purpose they think proper, and the Telegraph Conference of five years ago decreed that the public should have eight languages with which to form their codes, and make the words in those languages mean anything they like. At the same time the stipulation was that only words should be used which are common to the usage of those eight languages. Unfortunately there has arisen within the last year or two—especially the last twelve months—a number of enterprising gentlemen who manufacture the commercial codes, and they totally and entirely disregard the languages. They put odd syllables together and make such combinations as to lead us to a most disastrous result, the effect being we are carrying three messages just now for the price of two a year ago. These are the bad points, and I will now state what we are doing to overcome them. We are at this moment doing all we can at Madrid, with all the influence—diplomatic influence—that we can bring to bear upon the Spanish Administration to get the lines put in better order. I have had a long letter this morning—a telegram yesterday, and another on Saturday reporting progess—not so good on Saturday but better this morning, and I hope in the course of a little time—perhaps I should not say in the course of a little time—but in the course of some time we shall have the lines in Spain put in first class order. That alone will give us some increase of traffic. Then there is, as I daresay you all know from the papers, the commercial treaty just passed between Great Britain and Spain, which has long been in abeyance. That we think ought to make a large increase in our traffic. There has been a differential tariff against English trade for a considerable number of years; that is on the point of being removed. I think I read yesterday that it had passed the Cortes in Madrid. The next thing, gentlemen, is one which is the main reason for which I came on this Board, and it is the main reason for the Eastern Company having sought to get an interest in the affairs of this Company. Any one conversant with the map will see that the Eastern Telegraph Company have a land line through France, a land line through Italy, and through Austria, Germany, and Russia, and we have long thought it desirable that we should have one through Spain. Should we succeed in having a good line through Spain the same as we have through France, the Eastern Company then propose to take a new cable from Malta to Carthagena and Gibraltar, thus diverting a considerable amount of traffic to the Bilbao cable. We are trying with our agents in Madrid, and are backed up with the highest diplomatic influence in this country, to get that through line through Spain. It is the object with which the Eastern Company took an interest in this Company, and it is the sole reason for my being here. I hope to have a through line in connection with the Direct Spanish at Bilbao to work a large portion of the Eastern traffic. Now, that and the commercial treaty between Spain and this country should, I think, give a new phase to our traffic, and an improved condition of things. At all events, it is all that can be done. Then we have the Telegraph Conference coming off in August, by which the different telegraph administrations—by that I mean the Governments of Europe—will have their say about this abuse of code language, which is simply ruinous to commercial companies. I do not know that I have any other remarks to make. The accounts are simple, and any little increase or decrease here or there is not worth referring to, compared with the main object of getting this Company into a dividend paying state. Until our traffic increases, and until we get good lines in Spain, I do not see any specially encouraging features worth referring to. With these remarks, gentlemen, I beg to move "That the report and accounts now presented be, and they are hereby received

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and adopted." Very likely some gentleman has some questions to ask, which I shall be very glad to answer if I can.

Mr. ETLINGER seconded the motion.

Mr. BIRKIN asked if one or two lines were in existence when the £10 preference shares were created.

The CHAIRMAN: Only one.

Mr. BIRKIN said that that being the case, upon what grounds did they suspend the payment of the dividend on the preference shares, seeing that there was only one line of cable in existence when the preference shares were issued, and according to the Directors' own report, the present line was in perfect order?

Mr. BEARD asked how much money had been spent over the old cable, and whether it would not be better to abandon it altogether. It seemed to be a halter round the company's neck, and to do a great deal of harm both to the preference and ordinary shareholders.

Mr. BAKER considered that the report was very unsatisfactory. On the 14th of January the news came upon himself and many of his fellow shareholders like a bomb that the dividend would not be paid on the preference shares, and the shares fell from 14 to 10. He thought the time had come when they should call up the remaining £1 a share on the ordinary shares to pay the cost of the repairs. If they were going to spend a lot of money on repairs, what was the use of having £13,000 uncalled? It seemed to him the time had arrived when it ought to be called up at once. He noticed on the register there was a large number of shares held by the Eastern Company, and possibly it was not in the interest of that Company that the call should be made; but the £1 call, with a portion of their reserve fund, would be ample to pay for any repairs that might be requisite, and then, instead of going on, as the Chairman had foreshadowed, with the expectation of getting a dividend in, perhaps, 10 years, they would be able to pay one at once on the preference shares. He suggested that the call should be made at once and spent on the overhauling of the old original cable of this Company.

Mr. COCHRANE thought they should be informed what was the amount of interest held by the Eastern Company. He also thought they should have the precise case on which the opinion of counsel had been obtained that they could not pay the dividend on the preference shares. The question of paying dividend when capital was not intact had come before other companies besides their own, and he thought it would be fair to the shareholders and Directors that they should be clearly informed as to the position in which this Company was placed. He was a holder of both classes of shares, but principally of the ordinary shares. Although he had asked this question, he did not look with great alarm at the non-payment of the dividend on the preference shares, because it was cumulative and would go on till such time as the Company was able to pay it, and the ordinary shareholders would not get a farthing. On a previous occasion the Board refused to hear criticism, and they were then assured by Mr. Neil Bannatyne that the course that was being adopted was one that was likely to bring them into smoother waters. He was afraid they had been listening too long to suave promises. He thought the Company had better be handed over bodily to the Eastern. There were two representatives of the Eastern Company on the Board, and possibly the interest of the Eastern was not compatible with that of this Company. He did not think that the majority of the Board should be representatives of the Eastern Company. He thought it would be desirable that some committee should be appointed to report as to the best mode of carrying on this Company.

The CHAIRMAN, in reply to the questions, said they had only one line to Bilbao, and that had never been a very good line. With regard to getting rid of the old cable, that might be brought before the shareholders at some future time, but he thought that first of all they ought to investigate it at two or three points and see if the whole of the cable was equally bad. It did not appear to have been a cable that was ever fit for the bottom on which it was laid. With regard to calling up the remaining £1 on the ordinary shares, they could not do that for the purposes of repairs. Besides, it would not bring in sufficient money, as he thought that anything short of £20,000 would be useless, even in making a trial. The Eastern Company held about £30,000 in ordinary shares, and were doing their best to obtain the line he had referred to. It would be no use for the Eastern Company to absorb the Direct Spanish, as another company would be formed at once. Whether he was re-elected or not, to him was a matter of perfect indifference. In the financial papers he was accused of being on too many Boards. He was willing to be on fewer. He was certain of this—it was immensely to the interest of the different telegraph companies that the Directors were the same persons, because if that were not the case the rivalry would be disastrous. It was by keeping together and knowing each other, and working amicably, that they were able to keep up a dividend somewhere. He thought they would very soon regret it if the present Directors were displaced, as it would break off a combination. The traffic of the Direct Spanish was far too small for the Company to stand alone or to fight. It would be very easy for the Eastern Company to find money enough to lay a cable to Spain in opposition to this Company, but they had never opposed any existing company, or entered into rivalry with any other company. For that reason they made a joint purse with the Direct Spanish years ago, and he did not think they would regret the connection between the Eastern. He thought he had explained all the points. There was nothing to hide and he had nothing to be afraid of.

The motion for the adoption of the report was then put and carried unanimously.

Mr. BAKER asked the solicitor's opinion as to the practicability of making the call of £1 a share on the ordinary shares.

The SOLICITOR replied that he had not considered the point, and could not give a reply without reading the prospectus.

Mr. BAKER thought they should make the call, as they were sadly in want of money.

The CHAIRMAN said it would not meet the case, as they could not use the money for the repair of the cable, and they only wanted money for that purpose.

Sir James Anderson and Mr. Etlinger, the retiring Directors, were then re-elected, and Mr. Herbert R. Duke, the retiring auditor, was re-appointed.

A vote of thanks to the Chairman and Directors then terminated the proceedings.

LEGAL.

Thornton v. The Electrical Power Storage Company (Limited).

In the High Court of Justice, Queen's Bench Division, on Monday last, before Mr. Justice Kay and a special jury, an action was brought by Mr Frederick Thornton, an electrical engineer, to recover damages from the defendant company for being dismissed from their service as works manager without notice or just cause. The defendants admitted that he was dismissed without notice, but denied that the dismissal was wrongful.

Mr. LOCKWOOD, Q.C., in opening the case for the plaintiff, said that Mr. Thornton became engaged by the defendant company to serve them in the capacity of works manager in the year 1882. Prior to that date he had been in the employment of Messrs. Latimer Clark, Muirhead and Co., and his attention was called to an advertisement which he saw in the *Engineer* of the 15th September, 1882, in the following terms:—"Wanted a thoroughly energetic man to conduct the entire management of large electrical works. One with a knowledge of French preferred. Salary £1,000 a year." The plaintiff accordingly made application for the appointment. At that time the chairman of the company was a Mr. Daniel Cooper, and a Mr. Volckmar the managing director, and the company was originally started for working the patents of the latter gentleman. After some interviews with the managing director, Mr. Thornton eventually received his appointment as works manager; but the salary was not £1,000 a year, as set out in the advertisement, it being arranged that he was to come for a probationary term of three months, his remuneration to be £500 for the first year, the engagement to last for three years, and the salary to be increased at the rate of £100. On the 30th September an interview took place between Mr. Volckmar, the plaintiff, and the then secretary of the company, when it was pointed out to him the kind of duties he would have to perform, and he was told that he would be the sole responsible person present at the works. On the 9th October, 1882, he entered upon his work, and all went on smoothly. In the early part of the year 1884 Mr. Volckmar, who was a gentleman who took a very prominent part in the management of the company, was engaged a good deal upon the Continent, and consequently was not able to devote so much time to its affairs as previously. Mr. Collett was therefore appointed to act as general manager, but he had no authority over Mr. Thornton at the works, and again everything went on in a satisfactory manner. One of the Directors of the Company was a gentleman of the name of Courtney. He had been a director at the time of the plaintiff's engagement, but was out of England, in America. After the resignation of Mr. Volckmar he took a very much more active part in the management of the company, and in fact from that time assumed the duties of managing director. Apparently Mr. Courtney did not entertain the same high opinion of the plaintiff as had been held of him by Mr. Volckmar, and in August, 1884, for the first time a disagreement took place between Mr. Thornton and the company, which, however, blew over. Shortly after that date a Mr. Drake, who appeared to have been a connection of Mr. Sellon's (another of the directors of the company), was appointed to the office of managing engineer. Mr. Drake's duties could of course in no way clash with those of Mr. Thornton, and nothing occurred to create suspicion in the mind of the plaintiff until the 6th of October, 1884, when a letter was received by him from the company to the following effect, viz., that, in accordance with his request and in view of the recent appointment of Mr. Drake as managing engineer, his duties should be defined clearly. In the first instance the writer thought it well to enclose a copy extract from Mr. Drake's agreement:—"The duties of the managing engineer were to well and faithfully carry out all the instructions given to him by the company or the managing director of the company. He was to be responsible for the quality of all articles manufactured by the company, and for those purposes to issue all orders to the works manager of their factories and staff . . . . as may seem advisable, and to supervise all installations. . . ." His (Mr. Thornton's) duties would therefore be of the usual kind appertaining to the post of works manager, and by his being constantly at the factory he would be able to give a rigid supervision to the manufacture of secondary batteries. Further details were to be settled at a conference. At the interview he was forbidden to correspond "direct" to parties as he had been in the habit of doing, and certain other of his duties curtailed. The plaintiff afterwards wrote further: "With reference to your letter of the 4th, I beg respectfully to inform you that the duties of the engineer conflict with those under my agreement for three years. . . . I mean to adhere to the terms of the agreement." On the 9th of October, before they could have received his letter, he got a memorandum instructing him to attend the Board meeting on that morning, and he accordingly went to the head offices for that purpose. Shortly after his arrival he was called in by the secretary (Mr. Dell), and informed by Mr. Courtney that he was summarily dismissed. The justification of the defendant company relied principally on the following pleas:—1st. That though he was on the 6th October told to write no letters excepting through head-quarters, he afterwards did correspond with the Swan and Edison Company "direct." 2nd.

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That he gave an order for red lead after Mr. Courtney had told him he was not to do so any longer. 3rd. There were charges that he had not properly kept the books. With regard to that charge Mr. Thornton had not been able to have the books kept as he wished, owing to the fact that in consequence of the company not having been such a success as was anticipated, his clerical staff had been reduced to such an extent as to prevent it. After some trivial matters there was this suggestion, not made openly in the pleadings, viz., that he had received from persons with whom the company were dealing something in the nature of a commission, which suggestion would be denied by Mr. Thornton, and he would call in other persons to contradict it.

Mr. Frederick Thornton, the plaintiff, was then called and examined by Mr. Haigh. In the course of his evidence in chief, which bore out the the above opening statement, he positively denied having received any commission on any goods either bought or sold.

Witness was then cross-examined by Mr. Webster at considerable length as to the condition of the books. He stated that there was an old lead battery formerly belonging to the defendants. He had valued it in December, 1883, at £220. In July, 1884, he sold it to a Mr. Browne for £55. Mr. Browne carried on business in Wolston, and was a metal merchant. The battery consisted of 56 wooden boxes, lined with sheet lead, and filled with lead plates, one half positive and one half negative. His estimate of '83 was made up, as far as he could remember, as follows:—56 lead-lined boxes, at 30s. a piece, £84; 15 tons of lead plates, £9 a ton, £135; and 3cwt. of copper, at £2 a cwt., £16, making a total of £225. In the day book there was an entry "Old lead plates, terminals, &c., from the battery, as agreed, £55." He did not put down that it was the whole of the battery, because it was simply sold as old metal. In July, 1884, lead had dropped about £4 a cwt. He told Mr. Courtney that the battery had been sold some time at the end of July. Browne did some smelting at 30s. a ton, including carriage both ways. Did not know that Messrs. Eutolms did it cheaper. Had sold Browne some old copper wire at 30s. a cwt., and bought back old copper when cleaned at 70s. Could not have been used for their own purposes exactly as it was. Thought 30s. a cwt. a fair price considering the state it was in. He gave an order for ten tons of red lead, the value of which was about £14 a ton, but did not do so because he was unwilling that the order should go through the head office. It was wanted at the time. The works were in telephonic communication with the head office.

Mr. Arthur Browne, metal merchant, of Wolston, and two former *employés* of the defendant company, were then called, and the plaintiff's case concluded.

Mr. Webster then opened the defendants' case. He said that if the jury found the defendant company had been in the wrong they would then have to pay the plaintiff £700 for the year, reducible by what he had been earning since his dismissal, or was likely to earn, which would make it a sum of between £300 to £400. He had been struck by the point of the question which had been put to the plaintiff by the foreman of the jury as to whether he (the plaintiff) had to keep the books under his agreement. He did not complain and never had complained of the fact that particular entries were not made in a particular manner, for that he was not responsible; but he as works manager, like every works manager, had to direct what entries should be made as to matters which came under his superintendence, and in that respect he very grossly neglected his duties. Further, it was because he had simply grossly neglected his duties, quite apart from those of keeping the books, that he asked the jury to find that the company were justified in dismissing him. In the month of July some of the directors interviewed Mr. Thornton at the works, and told him that things were very unsatisfactory. He did not receive the communication as he ought to have done, and was very insolent; however, he afterwards apologised, and the matter blew over. But on the 6th of October the directors finding, as they had been finding for months past, that materials in vast quantities were being ordered at the works, and that they could get no account whatever—moreover, that the work turned out was out of all proportion—they determined to keep a check, and told the plaintiff that all orders were to be sent out through the head office. Notwithstanding that, on the 7th October, without the slightest communication with the head office, he ordered fourteen tons of red lead, of the value of about £130 or £140. That red lead was only delivered, it turned out, on the 22nd October, so that it was not urgently required, and the factory was in telephonic communication with the head office. The directors had the greatest difficulty in finding out how it was that their works were costing such an enormous sum to carry on. They had interviews with the plaintiff, who explained as best he could, but when they came to look at the books they found that from the beginning of the year 1884 no entry had been made of any sort of the cost of the batteries going out, or of the repairing those returned. The very first thing a works manager ought to be able to do was to give information as to what the manufacture of the goods was costing, and to show thereby whether his management were satisfactory or not. During the time of Mr. Thornton's management the cost of labour alone was 85 per cent., which, after his dismissal, was reduced to 45 per cent. Then what was the position of Mr. Browne? He would say a word or two as to that. Mr. Thornton at the end of 1883 valued the old works battery (it was in his own handwriting) at between £230 and £240. Mr. Sellon, who was no fool in these matters, would tell them that there was about 22 tons of lead in the old battery, that the plaintiff never said one single word as to that bargain, and that it passed out of the company's possession into Browne's for about £50, without an entry which they could trace, and, at Mr. Browne's own showing, he got about £150 for it. Then there was the copper wire which had been sold to Browne, and sold by Browne again to Messrs. Johnson and Matthie just as it was at a large profit. Mr. Sellon would tell the jury that it was perfectly untrue to say that it was unsuitable for their own use. That was not all. For a considerable time the company had been in the habit of getting their lead smelted at Messrs. Eutolms, and when Mr. Sellon was conversing with the plaintiff on the matter the latter mentioned the name of Browne. Mr. Sellon had never heard of it, and asked him why he had sent the stuff to Browne, and he told him that it was because his charges were much lower, which explanation perfectly satisfied Mr. Sellon; but on subsequent inquiry he found that the statement was simply an untruth. He asked the jury to defer their judgment until they had heard what the defendants had to say.

Mr. John Scudamore Sellon, examined by Mr. Moulton, said he was a director of the defendant company and a partner in the firm of Johnson, Matthie, and Co. As far as he could recollect he heard Browne's name mentioned in September, 1884. The dismantling of the old battery was determined on in accordance with the recommendation of Mr. Thornton. He asked the plaintiff in June, 1884, what it was worth, and he said between £200 and £300. Had not the slightest recollection of his ever telling him that it was worth about £80. Did not think it likely, as he knew the value too well. With regard to the smelting, Mr. Thornton told him that he had applied to Emptholden's and Lock, Lancaster, and Co., and their prices were too high. Thornton said Browne smelted lead on better terms than the well-known smelters. The proceeds given by Mr. Browne he should think were very much less than those given by the regular smelters. Browne's average return would be about 66 per cent. His returns should have been about 85 per cent. on the old plates. The lead linings in the boxes would yield more. The regular smelters' charge for conversion was about £1 a ton on what they took in. He calculated the loss on that particular transaction to the Company to be about £360, in comparison to what would have been obtained from one of the regular smelters. The quality of the cotton-covered copper wire was the best known. The cost of drawing it would be about 4s. to 5s. a cwt. Mr. Thornton had bought scrap copper from Browne at 70s. The copper wire would have been the very best thing possible for the purpose for which the scrap copper was required. He should consider 70s., the price given by Thornton to Browne for scrap copper very high. In July and August to September india rubber rings were purchased by Mr. Thornton at 5s. a pound; they ought to have been obtainable at 3s. a pound. They had done so since Mr. Thornton had left. Mr. Thornton had purchased at various times a considerable quantity, amounting to about 2,000 to 3,000 tons.

Cross-examined by Mr. Lockwood: He was also a member of the Anglo-American Brush Company, in which he took a great interest. Mr. Drake was formerly in the employ of that company. His calculations as to prices were based on the invoices. They ought to have been presented to the Board at their meetings. He could not say that they were not. It was the duty of two of the Directors to go through the invoices after the manager had ticked them. Colonel Stewart and Mr. Ladd were the two gentlemen. It was also their duty to call the attention of the Board to any excessive charges, &c. Did not know the battery was to be sold, or that it was ever brought before the Board. The company was formed for the purpose of working the patents of himself, Mr. Volckmar, and Mr. Swan. Mr. Volckmar and himself had differed as to the management of the company considerably. Mr. Courtney had agreed with him in most matters. Mr. Courtney was also a "Brush" director.

Mr. J. Irving Courtney said he was the managing director of the company. Was not a technical man; he was a barrister. The question of the sale of the battery was never brought before the Board. Mr. Thornton never complained to him that the clerical staff was insufficient for the keeping of the books. Once he had asked him to increase his staff for the purpose of taking stock, which he refused to do owing to the position of the company. Mr. Thornton offered the books for his inspection, but it was late, and he did not look at them.

Cross-examined: Remembered the Board being consulted as to the "breaking up" of the old battery.

Mr. F. Drake stated he was the managing engineer of the defendant company. Had seen some motors which had been sold by Mr. Thornton at £2 10s. each. They had since been priced at £5 5s. each. Considered too much had been given for the india rubber rings.

Cross-examined: No motors had been made since.

Mr. Justice Day: There is only a difference of 5s. in the two estimates.

Mr. Keen, chartered accountant, stated that he had examined the books of the company. The prime cost book had not been written up for the year 1884. They were not kept in such a way as to enable a person looking into them to get at the prices of various goods at once, without picking out the information from a number of books with a good deal of trouble.

Mr. Moulton and Mr. Lockwood then addressed the jury for their respective sides.

Mr. Justice Day, in the course of summing up the case, said there was no doubt that the plaintiff was dismissed one year before his time was up, and thereby he lost £700, but he had since, to his credit, been fortunate enough to obtain employment at a salary of £300 a year, and therefore the jury would have to take that into their consideration in fixing the amount of damages, should they be of opinion that the plaintiff was wrongfully dismissed. If they were of opinion that the plaintiff wilfully disobeyed the lawful orders given to him by his employers, the employers were then entitled to dismiss him; also, if his conduct as manager was not that which the defendants had a right to expect—that was to say, if he "substantially" neglected their interests. He used that word because it was not every act of negligence that would justify dismissal. Casual negligence would not justify a master in dismissing a servant; the law had to consider whether the servant had so misconducted himself as to render a continuance of the relations between master and servant unreasonable.

The jury retired to consider their verdict, and after a lapse of twenty minutes returned with a verdict for the plaintiff for £80.

Mr. Justice Day delivered judgment accordingly.

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NOTES.

THE RISING IN COLUMBIA.—The telegraph between Aspinwall and Panama has been cut.

THE NEW FRENCH MINISTRY.—M. Sarrien has been appointed Minister of Posts and Telegraphs, in place of M. Cochery.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 3rd April amounted to £2,982.

THE WEST COAST OF AMERICA TELEGRAPH COMPANY.—The gross earnings of this company for the month ending 31st March amounted to £4,290.

THE ELECTRIC LIGHT IN BRUSSELS.—The lowest estimates for lighting the new Theatre Flamand in Brussels are:—Gas, £1,509; electricity, £1,846.

ELECTRICITY AND WARFARE.—Arrangements have been made at the Garrison Point Fort, Sheerness, for firing the 38-ton and 25-ton guns by electricity.

THE "GERMANIC."—During the recent gale in the Atlantic the electric light on board the ss. "Germanic" was extinguished in some parts of the vessel.

THE ELECTRIC LIGHT FOR BALLOONS.—A balloon ascent was recently made from Philadelphia, the aeronaut taking with him an electric light for use above the clouds at night.

ERRATUM.—In our issue of last week the paper of Mr. Preece was incorrectly described as being read at the Society of Telegraph Engineers. It was read before the Royal Society.

DIRECT SPANISH TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the month of March were £1,455, against £1,764 in the corretponding period of last year.

THE EASTERN TELEGRAPH COMPANY.—The traffic receipts of this company for the month of March, 1885, amounted to £68,296, and to £67,285 in the corresponding period of 1884; increase, £1,011.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half-month ended the 31st March are £3,838, as compared with £3,543 in the corresponding period of 1884.

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company are as follow:—Receipts for March, £23,200; 1st January to 31st March, £64,400; corresponding months, 1884, £60,600; 1883, £57,200.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts for the week ending 3rd April were £2,394, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY.—The traffic receipts of this company, including Government subsidies, for the month of March, 1885, amounted to £46,193, and to £41,351 in the corresponding period of 1884; increase, £4,842.

CUBA SUBMARINE COMPANY.—The number of messages passing over the lines of this company during the month of March was 4,116, estimated to produce £3,500, against 3,852 messages, producing £3,296, in the corresponding month of last year. The traffic receipts for the month of December, estimated at £2,500, realised £2,553.

THE LIGHTING OF THE PADDINGTON STATION.—The arrangements for electrically lighting the general offices and hotel at Paddington Terminus, and the Royal Oak and Westbourne Park Stations of the Great Western Railway with incandescent lamps are approaching completion. It is expected that the work will be finished in about six weeks.

THE GINGERBREAD FAIR IN PARIS.—The correspondent of the *Daily Telegraph* says:—On Sunday night the fair was in full swing, and as the electric light beamed steadily down on the gaily-decorated booths, the bespangled and brawny *saltimbanques*, and the merry crowds of sightseers, the whole scene was interesting and picturesque to the highest degree.

AUSTRALIA.—An installation of the electric light has been successfully effected at the Eveleigh locomotive running sheds in Sydney. There are about 500 lamps in one bay of the shed, the light from each being reckoned to equal a 20-candle gas-burner. The Government of Tasmania intend laying a cable across the Derwent from Hobart to Bellerivie for the service of the battery on Kangaroo Point, and also the east coast districts.

THE EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—This Company notifies the interruption of the Zanzibar-Mozambique cable. Telegrams for places beyond Zanzibar will be sent on by a steamer which leaves Zanzibar for Mozambique on or about 25th instant. The company's repairing ship has been ordered to proceed to effect the necessary repairs. The manufacture of the duplicate cable to be laid between these points is well advanced.

COALING STATIONS AND THE TELEGRAPH.—Remarking upon England's naval defences in case of war, a Hong Kong telegram says:—"The public in the East demands the provision of torpedo fleets for all the coaling stations as an urgent measure of defence. The home yards could turn them out rapidly. A direct telegraph cable between Hong Kong and Singapore is also urgently required, the existing cables being in French and Russian hands."

PRODUCTION OF INDIA RUBBER IN BRAZIL.—The export of india rubber has increased rapidly in the past few years. From Pará and Manaos, the two principal ports in the Amazon Valley, the export during the five years from 1839-44 was 2,520,000 pounds, of the value of £79,000. In the five years 1854-1859 it had increased to 21,500,000 pounds, of the value of £800,000; and in the five years 1874-1879 to 66,000,000 pounds, of the value of £4,400,000. In 1882 the quantity exported was about 22,400,000 pounds.

THE ELECTRIC LIGHT IN ANTWERP.—The works at the central electric lighting station at Antwerp are being rapidly pushed forward, and it is hoped that everything will be in readiness by the opening of the Exhibition next month. The installation consists of 3,000 Siemens incandescent and 100 Gülcher arc lamps; four Naeyer generators of 150 horse-power each, two compound Cockerill engines of 400 horse-power, and four Gülcher dynamos, each giving, at a speed of 280 revolutions per minute, a current of 600 amperes and 65 volts.

THE ELECTRIC LIGHT IN VIENNA.—A valued correspondent, writing from Vienna, informs us that the Imperial Continental Gas Company have obtained the concessions for electrically lighting the Opera House and Burg Theatre, and are commencing work at once. The same company have the contract for the Bucharest Opera House, which is to be lighted on the Edison system in a few days, and have furthermore obtained a ten years' contract to light the New Royal Palace at Bucharest. The installations are going on well at Temesvar,

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the life of the incandescent lamps averaging already about 1,800 hours.

TELEGRAPHIC COMMUNICATION WITH THE AFGHAN FRONTIER.—The *Daily Telegraph*, in a fourth edition, says:—We are able to state, from inquiry in the best informed quarters, that the gravity of the events already announced is not diminished by any particulars received at the Government departments. The explanation of the fact that the tidings have arrived from St. Petersburg, is that the wire by Meshed has been cut, consequently no telegrams have for some days reached the British Government. The Russian wire is continuous from St. Petersburg to Merv, and it is by this line that the intelligence has been brought.

MILLAR'S PATENT COVERED RIBBON WIRE.—Some of our correspondents are at a loss to understand the nature of Mr. Millar's patent, seeing that this class of wire has been manufactured by Messrs. W. T. Glover and Co., Messrs. Shaw, Connolly and Co., and other firms for many years past. We wrote our description from the samples forwarded to us by the patentees and manufacturers. They appear to us to bear a close resemblance to the anti-capillary wound wires shown to us by Messrs. Shaw and Connolly, being covered with a double strand of cotton wound in opposite directions, but for further particulars of the patent we must refer our correspondents to the manufacturers themselves.

ELECTRIC JEWELS.—The electric light has been introduced with extremely pretty effect in the pantomime at the Theatre Royal, Belfast. Miss A. Glover, who sustains the part of Electra, carries four lamps throughout the performance, whilst in the transformation scene thirty additional lamps are employed as head-dresses. The current is supplied by small accumulators, manufactured specially for the occasion by the Belfast Electric Appliances Company, who have charge of the installation, while the lamps used are Swan and Edison 4-volt, which are both reliable and economical for this purpose. We believe that this is the first time that as many as four lamps have been effectually run off one battery during a whole pantomime.

ELECTRIC LIGHTING FOR STEAMSHIPS.—The new Wilson liner, "Eldorado," which was launched from Earle's Shipbuilding and Engineering Company's yard on the 2nd inst., will be lighted throughout by electricity. The Anglo-American Brush Electric Light Corporation have received, from the Admiralty, instructions to supply at once two of their special slow speed Victoria dynamos, coupled to Brotherhood engines, to H.M.S. "Active" and "Shah" at Portsmouth Dockyard. The Union Company of New Zealand's steamer, which is now being constructed at the yard of Messrs. Denny Brothers, Dumbarton, will be furnished with a dynamo and engine capable of supplying the current to 300 twenty candle-power incandescent lamps. The dynamo, which is a very powerful one for its size, is being manufactured by the Anglo-American Brush Electric Light Corporation.

THE DANGER OF OVERHEAD WIRES.—One of the dangers of overhead wires has recently been illustrated in Chicago. A large fire occurred at the Langham Hotel in that city on the evening of the 23rd ultimo. Upon the roof of the hotel there had been placed a large structure by the telephone company, to which a goodly number of wires were attached. All who have handled aërial wires know the immense tension that is sustained by these frames, which are balanced by diametrically opposed forces, so that in a normal condition the strain is *nil*. In the case mentioned the wires leading in one direction were destroyed and disconnected by the heat, and the strain, coming upon the wall of the structure, pulled a section of it over, with the unfortunate result of burying nearly the whole of the fire patrol crew, who were at work, two of whom were killed and others badly injured.

THE ELECTRIC LIGHT AND WEATHER VANES.—We are informed that an enterprising firm of brewers at Vauxhall are about to erect an immense weather vane in the shape of a bottle, 20ft. long and 6ft. diameter, on the summit of their premises. It is proposed to light each end of the bottle with a powerful arc light of 2,000 candles—the one showing red, the other white rays, so that the direction of the wind may be ascertainable by night as well as by day. Such a mass, though built as lightly as possible, requires some skill to arrange for a free movement on its centre. Therefore, it has a stem of about 14ft., accurately and well fitted inside a tower, the top support being on rollers, while the base rests in a glycerine bath. The function of the latter is to ease the weight, which is 3½ tons, from its roller bearings. The idea is a novel one, and illustrates another of the many uses to which the electric light readily and effectively lends itself.

PORTABLE ELECTRIC SAFETY LAMP COMPANY. — This company proposes to adopt and carry into effect an agreement dated December 30, 1884, and made between Ernest Moreton, of 25, St. Margaret's-road, Brockley, Kent, of the one part, and Richard Shirling Ingall, of Palace-chambers, Westminster, as the representative of the company, of the other part, for the purchase by the company from Ernest Moreton of the letters patent, No. 7,439, dated 15th December, 1884, relating to certain inventions for electric lighting, and also any other electrical inventions of M. Gustave Trouvé, of 11, Rue Vivienne, Paris. It was registered on the 20th ult., with a capital of £100,000, in £5 shares. The purchase consideration is £70,000, £33,000 thereof being payable in fully-paid shares. The number of directors is not to be less than three, nor more than seven; the first directors to be appointed by the subscribers; qualification 100 shares, remuneration £1,000 per annum.

OUR TELEGRAPHIC COMMUNICATION WITH INDIA.—It is possible that our position in regard to telegraphic communication with India in the event of our engaging in a war with Russia is not generally understood by the British public. It is a significant fact, and an ominous one, that English telegrams cannot be transmitted to the East without passing through, if not a foreign administration, at least a foreign country. By the lines of the Eastern Telegraph Company the route is Vigo, Caminha, and Lisbon, thence to Gibraltar, Malta, Egypt (both by the desert line and cable through the Suez Canal), and Aden; with an alternative route from London, *viâ* Marseilles, to Gibraltar, and from Bona to Malta. The lines of other companies pass through Continental countries and Russian territory. Should the necessity arise, the cables to Vigo and Lisbon could be joined through direct to Gibraltar and Malta, leaving only the Egyptian route to be guarded.

THE COST OF GAS VERSUS ELECTRICITY.—Although our electric lighting companies, says the *Pall Mall Gazette*, have not yet managed to distribute much in the way of dividends, they have the continual assurance that they are on the right track to earn them. The substantial half-yearly dividends declared by our great gas companies and the price of their stock evidence the profitable nature of the business. But New York—Edison notwithstanding—is *par excellence* the great profit-yielding city for gas. A special gas committee has been looking into the details of the business, and it finds that for the past ten years a profit of over 4s. per 1,000 feet has been made, or, in other words, two-thirds of the cost of gas to the

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consumer has been clear gain to the makers. Out of this it is computed that the gas companies have extorted from New Yorkers from six to eight millions sterling in ten years more than they were reasonably entitled to. No wonder there is ominous talk of imposing legislative control.

RECKENZAUN'S ELECTRIC TRAMCAR IN BERLIN.—We learn from the *Berliner Börsen Courir* that Herr E. A. Plewe, well known in Germany for the active part he took in organising the Berlin tramways, and also for being the sole *concessionnaire* of the Brush electric light system in Germany, is about to introduce Reckenzaun's electric tramcars in Berlin. Herr Plewe has recently visited England, and inspected the experimental car now running on the South London line, and having also received a favourable report on the system by Herr Zacharias, the engineer to the Berlin Electric Light Company, has ordered from the Electric Power and Storage Company the first of a set of motors, with gear and accumulators, intended for use on the line leading from the centre of Berlin to the Ausstellungspark, where a Japanese exhibition is shortly to be held. The line is 4½ miles long, and the cars are intended to perform twice the double journey, in all about 17 miles, with one charge. The accumulators will be charged from the electric light plant already existing at the exhibition.

THE BERLIN TELEGRAPHIC CONFERENCE.—The Victorian Government have been advised that the conference will take place on August 10. Amongst other things affecting the Colonies, the conference will be asked to consider the request of the recent Australasian Postal Conference, that a reduction might be made in the rates charged for press messages on Indian lines. It appears from communications which passed on this subject that there was no disinclination on the part of the Indian Government to meet the wishes of the Australian Conference, and no objection was raised by the telegraph companies interested, but Germany, as one of the Administrations interested in the telegraphic route to India, objected to any considerable reduction in the rates charged. As already stated, Mr. Murray Smith has been appointed to represent the colony at the conference, but, in the event of his inability to attend, the services of Mr. Cashel-Hoey, the secretary to the Agent-General, or Mr. Cameron Corbett, one of the Board of Advice to the Agent-General, will be sought.—*Colonies and India.*

LIGHTHOUSES AND THE TELEGRAPH.—A correspondent of *The Times*, recommending the connection of Eddystone Lighthouse with Plymouth by telegraph cable, writes as follows:—"All the arguments that have, in a measure successfully, been advanced to secure such communication between certain lightships and the shore apply with increased force to the Eddystone Lighthouse and Plymouth. We have recently had exemplified near Suakin the danger of the want of a ready means of ascertaining the approach or movements of an enemy. Major Templer's balloon now supplies the want. As the balloon is to General Graham's force so is the Eddystone to Plymouth. Plymouth is also an important mail packet station. The mail and other steamers from the East will shortly be bringing to the port many of our brave warriors in various stages of disease and bodily injury, whose friends, hitherto strangers to the port, will await with much anxiety tidings of the vessel's arrival. With the suggested telegraphic communication, under ordinary circumstances, some two hours' warning could be given in Plymouth, affording to anxious friends at any hour of the twenty-four ample time to get on board the steam tenders that communicate with incoming vessels. The advantage to our mercantile marine of such cable communication is so obvious that I need not occupy your valuable space by dwelling upon it at length."

A CORRUPTED METER.—Some amusement has been afforded the New York newspapers, says our American contemporary, the *Electrical World*, by the refusal of an electric light customer here to pay his bill, on the ground that he had not used any lamps. The Edison meter showed, or was said to show, that he had taken so much current, and he was therefore charged such and such a sum for it. It would be interesting to know if the particular electric meter which made a false charge of $9.29 had ever been associated with a gas meter. If it had spent any time in a cellar in the society of a gas meter it was quite possible that it was corrupted by the vicious influence and degrading example of the latter. That the gas meter does exert a most demoralising influence upon those who associate with it is sufficiently proved by the character of the managers of gas companies, not one of whom declines to profit by the false testimony of meters. Persons using the electric light cannot be too careful to remove their gas meters from the cellar before introducing the electric meter. The probability is that the electric meter is honest when left to itself, but that it is weak and easily led away by bad companions. If, on the other hand, it should turn out that the electric meter is as inherently vicious as the gas meter, the electric light will become as unpopular as gaslight, and the public will burn nothing but oil and candles.

A DIFFUSION PHOTOMETER.—M. A. Crova has designed a photometer for measuring luminous sources of high intensity. It is based upon the principle that when a translucent screen is placed in a uniformly illuminated field, in a direction normal to the incident rays, each point of the screen may be regarded as a luminous source and transmits light, the intensity of which depends upon the nature of the translucent material, in accordance with a law which also varies with the material, but in every case the rays diffused in a direction closely approaching the normal are equal in intensity. If there is placed behind the diffuser an opaque screen with an opening, the size of which can be varied at will, the intensity of the light normally emitted by this opening is proportional to the intensity of the luminous field on which the diffuser is placed, to a coefficient which depends on the nature of the translucent substance, and to the area of the opening, and varies inversely with the square of the distance. M. Crova employs a Foucaults photomometer, one half of the screen being illuminated by a standard light of one Carcel lamp placed at the end of a blackened tube one metre in length, whilst the other half is illuminated by the light to be examined. The latter passes down a tube which is movable on a graduated circle fixed at right angles to the axis of the first tube. At the further end of this tube there is a rectangular opening, the breadth of which remains constant, whilst the length can be varied by means of a micrometer screw. This opening is placed against the diffuser, and the size of the opening is altered until the two halves of the screen of the photometer are equally illuminated. For intensities up to 400 carcels the diffuser is made of ground glass, whilst for higher intensities opal glass is used.

THE ELECTRIC LIGHT AT THE GENERAL POST OFFICE, GLASGOW.—The Postmaster-General has entered into a new contract with Messrs. Muir and Mavor, of 140, Douglas-street, Glasgow, for electrically lighting the General Post Office buildings in that city. The installation at present consists of about 460 glow and 10 arc lamps. The currents are produced for the glow lamps from two 14-unit Crompton compound dynamos, while those for the arc lights are derived from three 4-unit Bürgin dynamos. The driving power consists of a pair of horizontal engines by Messrs. Marshall, of Gainsborough,

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each indicating 40 horse-power, steam being supplied at 80lb. pressure from two multitubular boilers by the same makers. The engines are connected with the driving shaft by means of double-friction clutch gear, which enables the engines to be interchanged or worked simultaneously without any interruption to the light. The dynamos are driven through Hoyt's short-lap leather belting, which was supplied by Messrs. Balderston and Co., of Glasgow. An ingenious arrangement is provided for each of the spare dynamos. This is a centrifugal friction clutch, consisting of a loose pulley with two radial arms, keyed on to the shaft, and pivoted to a boss. When the machine is required these arms are released by the withdrawal of a wedge, and the centrifugal force presses the leather shoes on their outer ends against the inside rim of the loose pulley and sets the machine in motion. Should one of the working machines become disabled, a spare one could thus be substituted in a few seconds. The whole of the post office is served by two circuits, one for the arc and the other for the glow lamps. The arc lamp machines are so arranged that the extinction of any group or groups of lamps does not affect the remainder. The glow lamp machines are arranged to work in parallel circuits by a board specially designed by Messrs. Muir and Mavor, which provides against the reversal of the current in one machine by the other. The test of the capabilities of the electric light in the post office is a severe one, as, of course, it is necessary that it should be not only reliable, but constantly available and steady. During the winter months the greater portion of the lights have frequently been required to run for 100 hours consecutively, and in every respect the working is stated to be satisfactory.

THE TELEGRAPHIC SIGNAL.—There is an interesting little story in *Scribner's Monthly*:—"John Mills, the hero of the sketch, was a railroad engineer, and had been for a long time in the company's employ. When the new engine '59' was completed and placed on the road John was given charge of it, and he evinced a natural pride in his preferment. At one of the stations there was a young girl, a telegraph operator, between whom and the engineer there had sprung up a mutual attachment, and whenever '59' came along Kate generally managed to be at the door and exchange signals with her lover. One day the train was detained at the station, and the locomotive detached and sent up the road to do some additional work, and Kate went along for a ride. As she listened to the sharp, shrill notes of the whistle, it occurred to her that she might teach John to sound her name in the Morse telegraphic characters, so that she could distinguish his signal from that of the other engines, whenever his train approached. The plan worked to a charm, and far and near the whistle shrieked K-a-t-e, until one day, as the operator stepped upon the platform, she overheard a conversation between two young men, and learned that they understood the signal, and were laughingly wondering who *Kate* could be. Their means of communication having been discovered, they were obliged to discontinue it. In the meantime, Kate had, by means of the telegraph, made the acquaintance of a young lady, an operator in a distant city, but whom she had never seen, and to her she made known the fact that the secret had been discovered. Then her friend suggested a plan as brilliant as it was ingenious. It was simply to arrange a means of telegraphic communication between the approaching train and the station, so as to ring a bell hidden away in the closet in Kate's office, engine '59' being the only one provided with the means of completing the circuit, which was done by laying the poker upon the tender-brake so as to touch the wire in passing. Kate found an opportunity to acquaint John with the proposed plan, and in the meantime had found an abandoned wire which ran for a long distance close beside the track, and which she proposed to use for carrying out her purpose. Thanksgiving Day came soon after, and John fortunately having a holiday, he and Kate went bravely to work, and before the day had ended the task was completed, and proved a complete success. The finale of their love episode is as dramatic as their telegraph line, was ingenious; the latter not only does all that is expected of it, but is the means of preventing a collision, and, eventually, of obtaining for John and his scientific *fiancée* much emolument and consequent happiness."

THE NATIONAL TELEPHONE COMPANY IN ARBROATH.—This company some time ago intimated their intention of introducing their system into Arbroath, and also to connect it with Dundee on the west, Montrose on the east, and also Brechin, Forfar, and Kirriemuir. Since then their workmen have been setting up poles all over the town, chiefly on the tops of houses, and latterly they have been stretching wires to houses and offices, also fitting up the apparatus for the use of subscribers. On the 2nd inst. a number of gentlemen met in the Central Office of the company in Millgate, where they were welcomed by several Dundee gentlemen and directors. Mr. Bennett, general manager, and Mr. Miller, district manager, were also present, the latter conducting a series of interesting experiments, during which conversation was kept up with Dundee, Perth, Newport, and Broughty Ferry, all of which were satisfactory. A Dundee gentleman favoured the company with a song, a tune on the violin, and he also put the wires in contact with a musical box and a clock, the ticking of which latter was distinctly heard. Mr. Miller mentioned that the length of the wire between Dundee and Arbroath was 19 miles; that the number of poles erected was 350, averaging in length from 22ft. to 70ft.; and that the wire used was No. 2 galvanised iron. He also said that in Dundee the company had nearly 700 subscribers, and that in Perth they had other 120. In the Dundee district the average number of connections per day was just now 6,928, or upwards of 41,000 per week; and as each connection involved a question and reply, the number of messages sent by telephone per week was about 83,000. Mr. Bennett, during the course of the proceedings, remarked that the spirit of extension which was now characterising the Dundee district was going on in almost every other district of importance, and one of the latest proposals was to join Scotland and Ireland for the purpose of enabling their Glasgow subscribers to speak to their customers in Belfast. They were about to open an exchange in Stirling, and a connection would be established between that and Perth, which, when completed, would enable subscribers in Perth, Dundee, and Arbroath to speak to Glasgow and Greenock and all the other towns round about. Their programme also included Brechin, Kirriemuir, and Montrose, but they would have to see their way clear before making the necessary outlay in that direction, as they had great demands upon their capital and enterprise in the English and more opulent Scotch districts. They would, however, in time reach Montrose, and then they would press north to Aberdeen; and the end would be that all towns in the kingdom would be able to speak with one another.

ELECTRO-DEPOSITING VATS IN SERIES.—In an interesting paper, read before the American Institute of Electrical Engineers, Mr. H. B. Slater gave the following description of the apparatus employed by him in practice:—Connected with a vat containing 200 gallons of metallic solution was a small dynamo machine. The dimensions of the vat were—length,

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6ft. 6in.; width, 2ft. 6in.; depth, 2ft. In it were three rows of nine anodes each, each anode being 8in. by 12in. One row extended from end to end of the vat at equal distances from the sides. The other two rows hung close to the sides of the vat, only one side of each of the side rows being exposed directly to the work. There were two spaces for work, one on each side of the middle row of anodes. The anode surface was $6+6=12$ square feet, and on the other two only one side of each row $6+6=12$ square feet, giving a total of 24 square feet. The distance between the plates or anodes on each side of the anode row was 15in. The vat, with both rows of work filled up, held just 20 pieces, 10 on each rod. The articles to be plated were hung with their flat sides to the anodes, and as they were about 1in. thick the distance between anode and cathode was 7in. The resistance of the vat was ·242 ohm between the terminals while full of work with the current passing. This included of course the $-e$. The E.M.F. of the dynamo = 12·32 volts after running 3 hours, and the resistance = ·2 ohm. The resistance of the connections was practically *nil*. By Ohm's formula we have $C=\frac{E}{R}=27{\cdot}87$ amperes. As the maximum current obtained was with an external resistance equal to the internal resistance of the dynamo there was very little waste of power. On receiving orders to increase the output of work, it became necessary to increase the facilities for doing it, and an exactly similar outfit was placed side by side with the first one, including both vat and dynamo. In each of the vats was placed another row of anodes, and so arranged that there were three spaces for work instead of two, as before. This increased the anode surface by one-half the original amount, viz., from 24ft. to 36ft., and as this increased the cross-section of the circuit in each vat by one-third, it of course produced a corresponding decrease of resistance. But by inserting this row of anodes the width of the vat was divided by 3 instead of by 2 as before. Originally the distance apart of the anodes was $\frac{30}{2}''=15''$, now it was $\frac{30}{3}''=10''$. The simplest calculation will show that these changes had reduced the resistance of each vat to less than 50 per cent. of its original value. One of the dynamos was now dispensed with, and the two vats connected in "series" to the other dynamo. The vats are side by side, two feet apart, and the dynamo is placed between them at the end, connected by a short, thick wire from the + terminal to one of the vats, and by a similar wire from the vat on the other side of it to the − terminal. The dimensions were now as follow:—The E.M.F. and internal resistance were assumed to be as before, 12·32 volts, and ·2 of an ohm. The external resistance between the terminals of the "series" was now, however, ·2018 ohm, or a total of ·4018. By Ohm's law $C=\frac{12{\cdot}32}{{\cdot}4018}=30{\cdot}7$ amperes. By the series arrangement nearly 31 amperes of current passed through each vat, and a total effect of 61·4 amperes, compared with 27·87 amperes from the same machine through a single vat.

INTERESTING LIGHTHOUSE EXPERIMENTS.—The important experiments at the South Foreland Lighthouse Station, under the direction of a Special Committee of the Trinity House, have been brought to a close. An official inspection was recently made of the three experimental towers, and the plant and apparatus, for the purpose of determining what should be retained for future investigations. The investigations of the past year have been specially directed to the subject of the contested superiority of the three illuminants, gas, oil, and electricity. The three experimental lighthouses were adapted specially for the contest of electricity, gas, and paraffin oil for the supremacy. They were fitted respectively with new electrical apparatus, with Mr. Wigham's gas apparatus, and the six-wick oil burners in extensive use in the Trinity Lighthouse service. The electric light was furnished by three powerful arc lamps supplied with current by three Meritens electro-magnetic machines, each arc being of about 12,000 candle-power. These lamps were disposed in the lantern of the lighthouse in triform arrangement, superposed one above the other, and could be used separately or in groups. The Wigham burners, first used in these South Foreland experiments, were provided with 88 jets. Subsequently burners with 108 jets have been employed under a quadriform arrangement of four such burners superposed. Such burners in the photometric room have given an illuminating value of 2,400 candles; but in the experimental lighthouse they have not developed quite so much light. The Trinity Service six-wick burners have been employed for oil illumination; the candle-power of each burner being 800 candles; the diameter of the flame, 4½in., and the superposition of the lights in the lantern being triform in arrangement. Sufficient general information as to the observations of the lights is current to enable some interesting conclusions to be deduced, and not the least interesting or important is the established fact of the superiority of the illumination of the electric arc for penetration of the atmosphere in foggy or hazy weather. In dense fogs on the Foreland, the electric rays became visible at distances varying from 1,900 to 1,500ft. The oil and the gas have been detected together at from 1,500 to 1,250ft. The high temperatures caused by the combustion of such furnaces of gas in the lantern are a serious detriment. With the original 88-jet burners the temperature rose during the exhibition of the light to 200 degrees of Fahrenheit; but the use of four 108-jet burners has elevated it to from 300 to 350 degrees. At sea, the electric light is in the ascendant; it has been ascertained that, with the three illuminants shown as single lights, the rays of the oil and the gas were lost at eight miles, whilst the range of the electric was maintained up to 14 miles. With the lights all at full power under their respective combinations the gas and the oil were lost at ten miles, whilst the electric was a good light at 14½ miles, beyond which it was not pursued. The additional electric machines have been maintained by the engines and plant put down 14 years ago for the permanent electric lighting of the Upper and Lower South Foreland Lighthouses. The dynamos used in the experimental lighting have each five sets of 12 compound magnets, placed radially, making a total of 60, and there are 24 induction coils on each of the five revolving armatures connected in parallel circuit. According to the measurements taken, the current given off at the terminals, with 600 revolutions, the lamp being placed in the machine room, is 218 amperes, and the electromotive force 35 volts, the light generated giving 19,000 candle-power by photometric determination; the power absorbed being 13·5 horse-power. In regard to the ranges of the gas and oil lights in the series of experiments just concluded, it is desirable to point out that the lenses employed in Mr. Wigham's gas lighthouse were four of a vertical height of 4ft. 1in. In the oil lighthouse the lenses employed were three of 6ft. 6in. each. The total height of the gas optical arrangement was 18ft.; the total height of the oil optical arrangement was 21ft. It may thus be seen why the ranges of these two illuminants should have been so near alike, as the beams corresponded to the respective vertical heights. With the electric light, as employed with the current of two machines sent through one arc, the optical apparatus was a single lens of 2ft. 9in. in height. The most important result in the whole series of experiments is the demonstration that the intensity of the electric light is superior in penetration of fog, mist, or rain to the larger superficial volume of combustion illuminants.

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RESEARCHES ON GAULARD AND GIBBS SECONDARY GENERATORS.

BY PROFESSOR FERRARIS.

Under the title "Ricerche Teoriche e Sperimentali sul Generatore Secondario Gaulard e Gibbs," the well-known Italian scientist, Professor Galileo Ferraris, has just published a reprint of a paper submitted in January last to the Academy of Sciences of Turin. The care and diligence bestowed by the author on this important and much debated subject are evidenced by the fact that his theoretical investigation and records of experiments fill not less than 73 large quarto pages. As is indicated by the title, the work is divided into two parts, the first theoretical, the second experimental, and it is satisfactory to find that the latter is a complete verification of the former. We cannot enter at length into the formulæ established by the author, which enable him to calculate this most important of disputed values, the efficiency, with an approximation of less than 1 per cent. to the real value; but we may briefly indicate the method of treating the question mathematically. He begins by considering the simplest possible case, where the primary and secondary coils are exactly alike, and have therefore the same coefficient of self-induction and of induction on each other: call this coefficient b. The coefficient of induction between the iron core and either of the coils we shall call a. It is further assumed that the iron core is sufficiently sub-divided to preclude the possibility of any internal currents, and that its total mass is sufficiently large to prevent any approach to saturation. Under these circumstances its magnetism at any instant is proportionate to the sum of the primary and secondary current flowing at that instant. It will be seen from this that the author tacitly assumes that there is no hanging back or sluggishness in the iron when changing its magnetism, an assumption which seems plausible enough when we consider that the core is composed of a bundle of wires. Let ϵ be the electromotive force of the alternating current dynamo, a periodic function of the time t; let r and c be resistance and current in the primary circuit, and r' and c' the same values for the secondary circuit; let, further, m be the magnetism of the core given by the formula

$$m = \mathrm{M}\,(c + c'),$$

where M is a constant of the apparatus; then we have the following fundamental equations:—

$$r\,c = \epsilon - a\frac{dm}{dt} - b\left(\frac{dc}{dt} + \frac{dc'}{dt}\right)$$

$$r'c' = -a\frac{dm}{dt} - b\left(\frac{dc}{dt} + \frac{dc'}{dt}\right)$$

With the Siemens machine used, the electromotive force ϵ at any instant, t, can be expressed as a function of the form $\mathrm{E}\sin\frac{2\pi}{\mathrm{T}}t$, where T is the period of a complete alternation [that is the time elapsed between two consecutive changes of sign], and E the maximum electromotive force.

From these equations the author calculates the currents in the primary and secondary coils and the magnetism in the core for special cases.

If $r' = 0$—that is, if the secondary coil is short circuited, and if its own resistance, ρ', is negligible—he finds $c = \frac{\epsilon}{r}$ and $c = -c'$.

In this case the primary current circulates as if the secondary generator did not exist, and the secondary current is at all times equal and of opposite sign to the primary current. As a consequence of this $m = 0$, which means that the core does not become magnetised. In this case there is no retardation of phase between the primary current and the electromotive force which creates it, but if the resistance in the secondary circuit be gradually increased a retardation sets in, whilst at the same time the primary current decreases. If the resistance of the secondary circuit is infinite the retardation reaches its maximum value, viz., a quarter of the periodic time of the machine, and the magnetism of the core assumes the maximum value $\mathrm{M}c$. For intermediate values of r' the retardation and the magnetism have smaller values, and useful work is done in the secondary circuit. The energy absorbed in the primary circuit is in both extreme cases ($r' = 0$ and $r' = \infty$),

$$q = \frac{\mathrm{C}^2}{2}\rho,$$

C being the maximum of the primary current, or crest of the wave, and ρ the resistance of the primary coil. For intermediate values of r' the energy absorbed in the primary coil is greater. That developed in the secondary coil can be expressed by the formula

$$q' = \frac{\mathrm{C}'^2}{2}r',$$

and hence the coefficient of internal efficiency is

$$\mu = \frac{q'}{q} = \frac{r'\mathrm{G}^2}{\rho r'^2 + (r' + \rho)\mathrm{G}^2}$$

where G is a value depending on the construction of the apparatus and on the speed of the dynamo

$$\mathrm{G} = (a\,\mathrm{M} + \mathrm{C})\frac{2\pi}{\mathrm{T}}.$$

It is evident that since $\mu = 0$, for $r' = 0$, and for $r' = \infty$, there must exist a value for r' for which μ is a maximum, and this is $r' = \mathrm{G}$.

It is interesting to note that the resistance in the secondary circuit, for which the efficiency of the generator becomes a maximum, is independent of the resistance of the secondary coil. The external or commercial efficiency is somewhat smaller than μ, on account of the energy absorbed by the resistance of the secondary coil. The relation between the total and external energy in the secondary circuit is evidently

$$\frac{q''}{q'} = \frac{r' - \rho'}{r'},$$

and the commercial efficiency of the secondary generator is

$$\zeta = \frac{q''}{q}.$$

It becomes a maximum for a certain value of r', which is, however, not the same as before, but somewhat larger. If the primary and secondary coil are exactly alike $\rho = \rho'$, and the maximum commercial efficiency is very nearly

$$\zeta\ \mathrm{max.} = \frac{\mathrm{G}}{\mathrm{G} + 2\rho\sqrt{2}}.$$

It will be evident that this value is the nearer to unity the greater G and the smaller ρ. The latter condition is self evident, as it simply means that the electrical resistance of the apparatus should be low; the former condition means that a, M, and C should be large and T small; or, in other words, there should be plenty of iron, and of the softest quality, in the core, the self-induction and the mutual induction of the coils should be large and the periodic time of the dynamo should be small, so that there may be a large number of alternations per second. As a matter of fact the inventors employ machines of short periodic time, the number of alternations lying between 260 and 300 per second.

An important question in the practical application of the secondary generator is that as to the maximum output obtainable. It is not sufficient to know that at one particular value of the resistance in the secondary circuit the apparatus should give a high commercial efficiency, we must also know whether it will be practicable to work it at that efficiency and yet obtain a reasonable output. To investigate this question the author introduces the conception of equivalent resistances, which, substituted for the secondary generator, would absorb the same energy as that transformed in the primary coil.

The resistance is equivalent to the total energy in the secondary coil divided by one half of the square of the

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maximum value C of the primary current, and for this the author finds the expression

$$\frac{q'}{\frac{1}{2}C^2} = \frac{G^2}{r' + \frac{G^2}{r'}},$$

which evidently becomes a maximum for $r' = G$. This is the same condition as was found for the maximum of internal efficiency, and the secondary generator has therefore this valuable quality (generally not shared by other electrical apparatus) that it gives a maximum of output when it is worked under conditions which make its internal efficiency a maximum.

The author next considers the question as to the energy computed when substituting an equivalent resistance for the secondary generator and its relation to the energy actually consumed when the generator is at work. The latter is always somewhat less than the former, and measurements taken without reference to this error make the apparatus appear less efficient than it really is. The author refers particularly to the tests made by Dr. Hopkinson and by M. Uzel, and finds that if μ' be the coefficient of efficiency found by these experimenters the real coefficient μ is given by the formula

$$\mu = \frac{\mu'}{\sqrt{1 - \left(\frac{r'}{G}\mu'\right)^2}}$$

The measurements objected to by the author were taken with a dynamometer and an electrometer, the indication of both being simply multiplied to obtain the electrical energy. This is a mistake, as no account is taken of the difference in phase between the primary current and the electromotive force at the terminals of the primary coil. In fact, if the secondary circuit be broken hardly any energy is absorbed in the primary coil, and yet current and electromotive force have considerable values. To avoid falling into the same error, the author has made all his measurements by a calorimeter, which is free from the objections which must be urged against the use of both the dynamometer and the electrometer. To the difference in the method of experimenting he attributes the fact that he found a maximum of internal efficiency when the resistance of the secondary circuit was about equal to G, whilst Hopkinson and Uzel found it for a much smaller value.

It remains to find the value of G. This is done experimentally by substituting for the secondary generator a resistance r_1, so chosen that the potential at the terminals of this resistance and the current are the same as in the primary coil if the secondary circuit is open. In this case there is no objection to the use of an electrometer and a dynamometer, because only comparative measurements are taken. As a result of his theory the author finds that in this case

$$G^2 = r_1^2 - \rho^2$$

and thus the determination of G is reduced to a simple measurement of the resistances r_1 and ρ.

For want of space we must abstain from reproducing the diagram showing the author's arrangement in his laboratory, which was connected with the dynamo by a circuit of about 600 yards total length, nor can we enter into a description of the ingenious methods by which he eliminated as much as possible any sources of error, or, when that was not quite possible, calculated the probable error. For these matters and for a complete table of the results we must refer our readers to Professor Ferraris' paper. We may, however, briefly record a few of the results. The secondary generator tested was one designed for the transformation of an electrical energy of 1·8 horse-power, and its particulars are given in Table A.

The core consisted of a central cylinder of wood, with a covering of straight iron wires to the thickness of about $\frac{5}{32}$in.

The primary current was 12 amperes.

Table B gives a few of the values obtained for the internal efficiency μ and the external or commercial efficiency ζ found by the formula, and ζ' found by experiment, with a varying resistance r' in the secondary circuit.

TABLE A.

External diameter of copper discs forming the primary and secondary coils, and placed over the core in alternating order	4·5 in.
Internal diameter	2·12 in.
Number of discs in primary coil	455
Number of discs in secondary coil	455
Thickness of discs	10 mils.
Weight of copper	40 lbs.
Weight of the whole apparatus	45 lbs.
Resistance of primary coil	·276 ohm.
Resistance of secondary coil	·285 ohm.

TABLE B.

r'	μ	ζ	ζ'
·28	·500	·000	·00
2	·876	·753	·74
4	·933	·867	·86
6	·956	·911	·90
10	·967	·940	·93
16	·974	·957	·95
22	·976	·963	·95
26	·975	·964	·95
32	·974	·966	·96
36	·973	·965	·95
40	·971	·964	·95

The author found by the use of the equivalent resistance that $G^2 = 500$, and we should therefore expect the maximum of internal efficiency if the resistance in the secondary circuit is $r' = \sqrt{500} = 22{\cdot}36$. This is verified by the experiment, as will be seen from the table given. The maximum of commercial efficiency occurs for $r' = 32$, which is also in accordance with theory.

The figures given by Professor Ferraris are so extraordinarily good that were it not for the high standing of this scientist we should hesitate to accept them as accurate. But with all the precautions adopted in the tests there is hardly room for doubt as to the value of the final results, and with so little loss in the secondary generator there is every reason to hope that, as far as alternating currents are concerned, the question of distributing electrical energy over a large area from a central station has here found a satisfactory solution.

Before concluding this notice on the work of Professor Ferraris we must briefly refer to his calculation of the "activity," or, as he calls it, the power of the secondary generators. The apparatus experimented on was capable of giving out 2·12 horse-power electrical energy with a resistance of about 22 ohms in the secondary circuit. It would then absorb about 2¼ horse-power in the primary coil. With any other resistance in the secondary circuit the power given out, and therefore the commercial value of the apparatus, would be less. Thus, for instance, at $r' = 10$ ohms (the resistance hitherto employed in the secondary circuit) it would only give out 1·58 horse-power, whilst 1·70 horse-power would be absorbed in the primary coil. The resistance in the secondary circuit was fixed so low on account of the result of the tests made by Dr. Hopkinson and M. Uzel, who found that the term $\frac{c'v'}{cv}$, which they erroneously took to be the efficiency, would be a maximum if the resistance of the secondary circuit were between 5 and 6 ohms. Professor Ferraris's recent investigation, however, shows that this term is not the efficiency, and that the most favourable resistance is from three to four times as great.

The author considers a core consisting partly of wood inferior to one consisting wholly of iron, and he finds that a similar apparatus to the one he tested, but without wood in the core, would give a maximum of output equal to 2·51 horse-power instead of 2·12 given by his apparatus. He concludes, therefore, that the introduction of a wood centre is a decided disadvantage.

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NEW ORLEANS EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I read in your issue of the 21st ult. an interesting notice of the New Orleans Exhibition, but one which I fear may unintentionally convey an erroneous impression of the nature and extent of the Edison Company's exhibit there.

During my recent visit to America I went to New Orleans, just before the opening of the Exhibition, and although it was even at the opening notoriously incomplete, I was enabled to see sufficient to give me an idea of the vast undertaking and to repay me for the tedious journey south.

The Exhibition buildings cover more area than any other hitherto erected, and, as may be supposed, the artificial lighting of them formed a very important feature. It was originally suggested to illuminate a large portion by gas; but owing, I believe, to the city gas works not being large enough for such an increased demand, this idea was very properly rejected, and contracts ultimately made with various electric lighting companies for the work.

The contract for the whole of the incandescent electric lighting of the building was made with the Edison Isolated Company of New York, who during the last year have so successfully lighted the Exhibitions at St. Louis and Louisville, each with about 4,500 lamps.

At New Orleans the capacity of the Edison installation is 6,000 lights, although only 5,000 are used. There is also another large plant located just by the Exhibition for lighting the Government buildings.

The installation for the Exhibition building is by far the largest isolated plant yet installed, and is exceeded only by the Edison Central Station system in New York.

Those of your readers conversant with very large installations can readily understand the magnitude of the task of properly wiring for such a number of lights, and I may add that, although only a temporary exhibition plant, the wiring is carried out with almost the same careful attention to details as if it were for permanent use.

The arrangement of the machinery is worthy of special note. Six Armington and Sims high speed engines are used for driving the dynamos, and the foundation for the whole is certainly unique. Owing to the peculiar condition of alluvial soil and the proximity of water to the surface, the customary brick and stone foundations are dispensed with, and a huge system of timber work in the form of a gigantic wheel is framed and bolted together and set directly on the floor of the machinery hall.

The six spokes of the wheel are square timbers bolted together one for each engine, and near the rim of the wheel are square timbers for the dynamos. The engines are so placed that they radiate from a common centre—the hub of the wheel—which sustains the thrust of the six engines, and in the hub the chief engineer stands overlooking and controlling the whole apparatus with his assistants. The spot is termed "Fort Edison," owing to its resemblance to some modern batteries.

I give a detailed description of it, as it is the first instance I have seen of any artistic grouping of engines and dynamos, as usually they are not at all pretty in appearance, being spread all over the floor with but little attempt at arrangement.

A considerable portion of my time while in America I spent in noting what improvements and developments had recently taken place in electric lighting, as it is natural to expect great advances in a country so proverbially progressive. It is difficult in so extensive a field to form other than very general conclusions, but it is certainly my opinion that incandescent is largely replacing arc lighting.

This is not only the case in shops, but also in the large mills, factories, and railway stations, &c., which we have frequently been told could only be satisfactorily illuminated by the arc. I will not take up your valuable space by discussing the question at any length, but I am of opinion that the present Exhibition at New Orleans will afford a further triumph to the incandescent lamp at the expense of its rival.

A large proportion of the favour shown the incandescent lamp in America is undoubtedly due to the present capable and energetic administration of the Edison Company, who are fast distancing all their competitors. The quality of the Edison lamp, high from the first, has been still further improved, and the life of the lamp has very materially increased. No less than 2,000 lamps per diem are now being manufactured in the American works alone, and it is estimated that 150,000 Edison lamps are at present in use.

Rough and ready work of a cheap nature was long ago proved to be a mistake in America, and although due importance must be given to using the most efficient material, a thoroughly successful installation requires careful and competent labour, with ingenuity of arrangement. All these matters have not only been preached but thoroughly well practised, and it is to the good results accruing therefrom that we must look for the real reason of the great and marked advancement of the electric lighting industry in America, rather than to any natural tendency of the American to rush after anything new.—Yours, &c., JNO. B. VERITY.

King-street, Covent Garden, April 7th, 1885.

BLACKPOOL ELECTRIC TRAMWAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been called to a letter in your last issue, signed "W. S. H."

If your correspondent wished to assist me in my work, don't you think the simplest way would have been to have seen me when he was in Blackpool? He might easily have done so by making inquiries, and would have learned that sumpholes are provided for. If he were a careful reader of your valuable paper he would have seen them therein described eighteen months ago.

I shall be only too pleased to receive suggestions from any one, but should much prefer receiving them direct, when if they are new I will publicly acknowledge them, and if already worked out the writer will be saved from publishing the incompleteness of his information.—Yours, &c.,

Blackpool. M. HOLROYD SMITH.

THE INVENTORIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I find in an article, "The Inventions Exhibition, Electric Lighting Arrangements," you have a mistake, which if you will correct in next week's *Electrician* you will greatly oblige.

Instead of Old London, *Mackie* lamps, it should have been *Lea* lamps. They are the same lamps that were in Old London last year and in the United States Court at the Fisheries.—Yours, &c., JOHN LEA.

75, Arlington-road, Camden Town, March 30, 1885.

DOMESTIC ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Allow me, through your widely circulating columns, to emit an idea which, simple and of the easiest application, may prove, though in a matter of minor importance, a useful addition to the ordinary appliances for household electric lighting.

One of the very numerous advantages of electric lighting for domestic purposes is the fact of the light being produced by turning the commutator, dispensing thereby with matches and lighters of all kinds. This advantage is, however, reduced to a minimum by the necessity of using a portable light of some kind in entering a dark room, so as to lay one's hand on the commutator.

It has not, as far as I am aware, occurred to any constructor to use Balmain's luminous paint in the construction of commutators for household fittings. I need not describe any special disposition, and it is evident that the cost would be but small, while the benefit resulting from such a disposition would be considerable, as all who are accustomed to the use of luminous match-boxes for the night table are aware that it is at all times easy, small as is the emitted light, to lay the hand on the box in the dark.—Yours, &c.,

Brussels, April 29, 1885. G. MONTEFIORE LEVI, C.E.

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THE LIFE AND CANDLE-POWER OF INCANDESCENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read many of the interesting letters and papers which have appeared since I ventured to question the accuracy of certain figures furnished by M. Foussat (see *Electrician*, pp. 246 and 294), but I am still of opinion that the method adopted in the preparation of them may have been similar to that of the learned Doctor Ananias, a notice of whose "Prolonged Experiments with Mr. Edison's Lamps" was given in *Zeitschrift für Electrotechnik* and in one or two of our English journals last summer, a few days before I first called attention to the subject.

He found that an Edison 16 candle-power lamp lasted exactly 1,000 hours if kept at its normal candle-power, and that the life of a 10 candle-power lamp under the same conditions was also 1,000 hours exactly. He made a careful record of the lives of lamps when burning at various powers above and below their normal 16 and 10 candles, and when the account of his investigations was published I plotted out the figures on a diagram, thus obtaining a very regular hyperbolic curve which suited *both* sets of lives, it being only necessary to use a horizontal scale of ¼in. per candle in the case of the 16 candle-power lamps, and a centimetre scale for 10 candle-power lamps.

I believe I am correct in stating that the results of extensive experiments carried out in this country do not agree with the reports received from abroad.—Yours, &c.,

W. H. MASSEY.

Twyford, Berks, April 6, 1885.

ON A PECULIAR BEHAVIOUR OF GLOW LAMPS WHEN RAISED TO HIGH INCANDESCENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Perhaps you will allow me to make a few remarks on the observations of Mr. Preece regarding the above subject.

The blue glow observed between the platinum supports of the filament when raised to high incandescence and the diffused glow that pervades the whole globe are, I think, greatly due to the quality of the carbon filament and the degree of vacuum obtained, and not only to the high incandescence of the lamp. If the vacuum is of such a degree as to be of very great resistance between the platinum supports of the filament, so as to lessen the possibility of a shunt across *a e* or *a c* in Fig. 1 of Mr. Preece's article, and the carbon filament is sufficiently hard and has not been previously heated in a hydrocarbon gas, the diffused blue effects can be entirely overcome, even if the nominal candle-power be raised seven-fold.

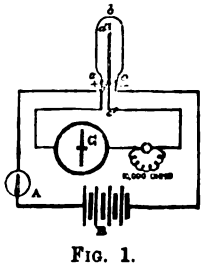

FIG. 1.

To show that the diffused blue effects between the platinum supports of the filament or the blue glow that pervades the whole globe when raised to a high degree of incandescence can be gradually lessened and entirely overcome, suppose a lamp is exhausted to a certain degree and raised to a high temperature, the blue effects mentioned above will appear. By continuing the exhaustion while the current is still passing through the filament the blue effects will become intermittent, until at length they entirely disappear. By further increasing the incandescence the blue effects will reappear for a short time, and at length they will again become intermittent, and again disappear as before. If the exhaustion be continued for some minutes, and the lamp hermetically sealed, it may then be raised to the highest incandescence without any blue effects being observable. Also, these effects may be produced by an alternating current as well as by a direct one. Neither is it necessary to have the distance between the electrodes increased any further than is required for what are now known as low resistance lamps in order to prevent an arc forming across the terminals, as lamps are now made requiring 150 to 200 volts in which the distance between the terminals is not greater than in 45-volt lamps.

Probably the time is not far distant when lamps which are at present reckoned as *high resistance* will be reckoned as *low resistance* lamps.—Yours, &c.,

JOHN B. DUNCAN.

Alexandra Electric Light Works,
Gateshead-on-Tyne, April 4, 1885.

MULTIPLE WIRES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Having frequently been taken to task by friends on the subject of multiple wires for parallel arc lighting, I have made the following notes, which may interest some of your readers:—

1. With a required difference of potential at the terminals of the lamp there must be a considerably greater difference of potential at the terminals of the dynamo, which must also be constant.

2. That this excess of E.M.F. over that required in the arc must be absorbed in independent resistances inserted with the arc in each derived circuit, and not in a common resistance as in incandescent lighting. For let the figures 1 and 2 represent the two methods of connection, and let

$V - V_2$ = the difference of potential at the terminals of the dynamo,

$V_1 - V_2$ = the difference of potential at the terminals of the lamps,

r = resistance inserted with each arc,

c = current in one lamp,

n = number of lamps parallel,

$R = \frac{r}{n}$.

C = total current from dynamo which is practically constant.

Then in Fig. 1,

$V - V_2 = (V_1 - V_2) + C R$ = constant,

* C R is also practically constant;

$\therefore\ V_1 - V_2$ = constant,

and $c \propto$ the conductivity of the arc.

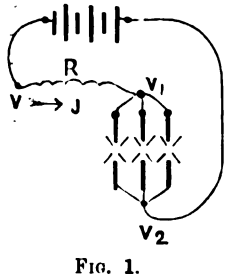

FIG. 1.

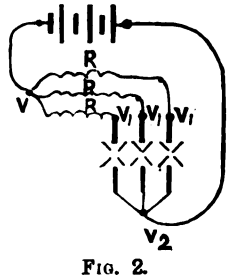

FIG. 2.

But the conductivity of the arc $\propto$ (or any way increases with) the current, and these two functions both varying together, any change in the arc is aggravated to the utmost; it is also curious to note that this change will eventually take the direction of excessive current. For suppose the conductivity of the arc to decrease, the current will go on falling until it is insufficient to support the carbon rod against the action of gravity, and the arc will then be shortened, and the opposite condition will set in, finally short-circuiting the lamp to a great extent.

In Fig. 2, on the other hand, $V_1 - V_2 = (V - V_2) - cr$; therefore, if c is increased, $V_1 - V_2$ is decreased and tends to reduce c; and *vice versâ*, if c is decreased, $V_1 - V_2$ is increased and tends to augment c. It appears, therefore, that separate circuits are advisable for this system of arc lighting, the resistance of each of which must be equal and sufficient to act as a current regulator to the lamp.—Yours, &c.,

GUY C. FRICKER.

7, Charlwood-road, Putney,
April 1st, 1885.

* It must be noticed that the variation in c may cause only an insignificant variation in C, until the whole system has broken down, so to speak, and degenerated into a general short circuit.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

NATURAL GROWTH.

People not accustomed to the dilatory ways of the "leading journal" were, no doubt, surprised a few days ago to see in its columns a long reprint of the Committee's Report on the Electric Lighting Act—or rather its recommendations for the amendment of that Act by a new one—at least a month after the document had been made public. The Committee's previous Report was similarly delayed. Possibly *The Times* may think there is no hurry; and in this we are inclined to agree with it; for as there seems to be no immediate disposition to consider the Committee's proposals favourably, and still less likelihood of Parliament devoting to them any attention whatever during the present Session, there is little need for hurry. The Committee lost no time in drawing up its programme, and discharged its duty thoroughly, besides showing that it knew exactly what it wanted, and was not afraid to ask for it. With equal promptitude the organs of the Government informed the electric lighting interests that if that was what they demanded they certainly would not get it. There is no inclination, we should imagine, on the part of the Committee to abate one jot of its just and reasonable pretensions; and so there the matter for the present ends.

On the whole we are not sorry to see this renewal of what has been called the "dead-lock." It has lasted a good while already, with results perhaps salutary to those who are responsible for the original Act; certainly it is, in our judgment, favourable to the permanent interests of electric light undertakers. Acts of Parliament there have been before now which have proved to be inoperative; they die, and are buried in oblivion; but this one is not so much the dead lion in the path as a live jackass, which sooner or later will be pushed aside by the pressure of public opinion. Time will show whether this or any other animal of the kind, duly disciplined, will be needed for the progressive locomotion of electric lighting industry; but in its present attitude the creature is a manifest obstruction, and useless for any active purposes whatever.

Meanwhile the natural growth of the electric light is advancing in the way we have always desired it should, and almost with as much rapidity as we had hoped it might. Every week our columns notify its experimental or permanent installation in fresh and unlooked-for places; and so far as we can discover there is no falling off in its popularity, or failure in its operations, except such as may be attributed either to incompetence or inexperience. These are faults which time will soon mend, every mishap with installations on a small scale furnishing useful lessons for the larger ones when their turn comes. This is how every new industry ought to grow; and fortunately the Act does not interpose any serious obstacles to natural development in the early stages of electric lighting.

Two examples of the kind we allude to are furnished in our columns this week. One is the arrangements, which are nearly completed, for lighting the general offices and hotel of the Paddington terminus, as well as the Royal Oak and Westbourne Park stations of the Great Western Railway. The installation is spoken of as the largest of the kind yet undertaken in this country. Be this as it may the auspices under which it will be carried out augur well for its success, there being no stint either of means or talent to carry it out successfully.

The other is of a somewhat different character, and is even more encouraging. After a two years' trial of the electric light in the General Post Office at Glasgow, the Department has entered into a contract of a more permanent and extended character. The success of this experiment so far is decisive as to the suitability of the electric light under most severe conditions, the lights having to be not only perfectly steady and trustworthy but always available. During the winter months, it is stated, the greater portion of the lights have frequently been required for as long a period as one hundred hours consecutively. In every respect the illumination and the general working have given great satisfaction, as is proved by the circumstance that the Postmaster-General has entered into a fresh contract for a longer period, and on terms which are no more experimental but commercial. Moreover, the Post Office has acquired all the lamps and fittings within the buildings as its own property, the engines and generating plant being located in premises belonging to the contractor in the rear of the Post Office. We understand that the contract is based on a fixed charge per month, which is the most rational arrangement for such installations when, as in this case, the average consumption has been approximately ascertained.

In this manner lighting by electricity may reckon to win its way in public favour; and, although the process may appear to be slow, it is sure, and as fast as under present conditions it is desirable to travel. When the Electric Lighting Act comes on again for consideration, as in due time it certainly must, the undertakers will not be so much at the mercy of the Board of Trade as they were three years ago. They can no longer be twitted with not being in possession of data on which a regulat-

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ing Act ought to be framed, or of being ignorant of the means of ascertaining the value of the commodity they wished to supply. They are entitled to the same terms as those enjoyed by the water and gas companies, subject only to such restrictions as experience has proved to be expedient for them; and by working and waiting patiently they will, we believe, get nothing less than these terms.

ELECTRICAL CONDITION v. RADIANT HEAT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: For reasons with which I have duly furnished you, my knowledge of dynamic electricity does not enable me to follow your intelligent correspondent "T" in his description of the stages of progress in that branch of science, as given in your last number under "The Wimshurst Electrical Influence Machine, &c." Until, therefore, I shall be in a position to have access to dynamos, batteries, and all their appliances, I must keep within the sphere in which I am supplied with facts, the *rationale* of which comes within my comprehension.

At page 402, under "Physical Society," March 14, Professor Guthrie, president, in the chair, you have given a paper read by Captain Abny, "On Recent Researches on Radiation," in which it is said that a hot body loses heat in three ways—by conduction, by convection, and by radiation. Now, one of the results of the inquiry referred to in my letter in your journal of the 14th was that if air were introduced into a vessel containing dead vegetable matter, such as dead moist leaves, the air did not undergo decomposition, but the leaves decomposed and formed carbonic acid, the hydrogen being evolved as a carbonate. That is decomposition *per se*. But if oxygen and nitrogen were introduced, the oxygen rapidly combined with the carbon, thereby demonstrating that air is a chemical compound, and that under decay the affinity of oxygen for carbon is much greater than for hydrogen, which was invariably evolved as a light carbonate—in fact, the fire damp of coal mines. But if a little organic matter were introduced into the vessel, as in putrefaction, the affinity of the oxygen was the same; but the hydrogen compounds were various, such as sulphurets, phosphurets, ammonia, &c.

If, however, a piece of bread, as in the process of making toast, be held in front of a *radiating* or bright fire the affinities are reversed, and the oxygen, instead of combining with the carbon, goes exclusively to the hydrogen, the carbon remaining intact; and if a piece of paper be placed on the bars of a grate under wood, as in the ordinary process of lighting a fire, the carbon of the paper not only remains intact, but the letter press may often be made out. So that under decay and putrefaction, with electrically negative conditions, the affinity is with carbon, whilst under positive conditions it is with hydrogen to the deposition of the carbon, as in the formation of smoke, soot, and lampblack.

Now, if a nail-rod, or a small round bar of iron of which nails are made, be put into an ordinary fire, it may be raised to cherry-red heat, and when taken out, if placed in front of the nozzle of a smith's pair of bellows, the cold air, or, more properly, compressed air, will raise it to the welding heat. So that in the compressed air and the incandescent or radiating fire there is the same influence, the only difference being that in the cold compressed air, which, as I have already said, will freeze meat in Australia and keep it in a frozen state while coming to us, that influence is greater than it is with the incandescence of combustion. What, then, may be the nature of the *radiation* from a fire or from a piece of iron raised to a red heat, I must obviously leave to the decision of rational minds, or to those that are to be influenced by matter-of-fact evidence. And, clearly if "radiation" from an ordinary fire be purely electrical, there can be no radiation of heat from an electric lamp, or what is called "incandescent"—as if all lamps or their lights were not incandescent.

It is said, "in the case of the carbon filaments of an incandescent lamp the loss of heat by conduction is insignificant" (of course there can be no heat to lose), "and a series of experiments has been made to determine the amount of radiation; that is, the energy expended as radiant heat for every unit of electrical energy expended in the lamp." What can "energy" (of quite recent introduction into science) have to do with heat or with electricity? "Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that at pressures between forty millionths and one millionth of an atmosphere, the radiation varies as the mean molecular free path."

How there can be "pressures" at an inconceivable fraction of atmosphere to me is quite incomprehensible; but in this latter part of the paper there is a fact recorded that evidently has escaped the notice of the captain and of Mr. Crookes, and that is that in high vacua there is a cooling influence, an influence which I suspect will be found to keep pace with the rate of exhaustion. I have said that electricity is the cause of cohesion, and Professor Tyndall has demonstrated that, if two planes be placed on one another in the air pump, on the receiver being exhausted the planes firmly adhere, but lose the cohesion on the air being introduced. Another fact, but the authority for which I do not at present recollect, is that if a lump of ice be put into a flask, and the flask be exhausted, the flask on being put over the flame of a spirit lamp may be made red hot, but the ice melteth not; on all which facts I think I may repeat what I have already suggested in the M.S. of "Electrical Condition," whether a vacuum be not a representation of space, or those regions in which the planets revolve round the sun. Our luminary being a highly heated or negative body, must necessarily be surrounded by an atmosphere electrical in proportion to his negative state.

My idea of the sun is that he is composed of non-luminous gases infinitely more dense than anything we are acquainted with, and which gases undergo no change, so that there is no waste. But science is constantly speculating on the amount of heat radiated by the sun, and how that loss of heat is restored. In a recent lecture delivered by Dr. Tyndall at the Society of Arts, after telling his audience what arrangements he made at Hind Head to determine the amount of radiation of heat from this planet into space, and that on a frosty night he warmed up two thermometers, and suspended one to a line and placed the other on cotton wool, and that the one on the cotton wool coated much faster than did the suspended one, he stated that the cause of the difference was owing to the cotton wool being one of the best of radiators and a bad conductor of heat, so that the thermometer could not recover from the soil the heat it lost by radiation; whereas I contend that this radiation of heat exists only in science, and that the cause of the difference was that the thermometer on the cotton wool was horizontal to space, which, under a clear sky, is constantly pouring down electricity, whilst the one suspended was vertical.

On the evidence of facts, however, it is possible that when the radiation distance was considered, there should have been conditions that no longer prevail. My father frequently observed to me when I was a lad that he could not think why it was that, whilst a shower of rain plummed the earth so, watering from a watering pot made it as hard as a brickbat. And had my father lived to the present time he might with equal reason express his surprise that, although at the period referred to, snakes, frogs, and toads—in fact, all the reptiles—swarmed, and ague prostrated whole families at a time, both the reptiles and complaints had disappeared from the locality he then resided in. The word plum is or was a common word in the West of England, signifying soft or spongy, the more especially in reference to the soil, and the why a shower then actually raised it was that the earth—that is, the crust of the earth—being then positive, the electricity brought down by a shower, as it still is, was actually repelled, and was most gratefully received by the atmosphere, which was then negative, the cooling influence on a summer day being most delightful. But now that the conditions are reversed, and the earth is negative, it not only gratefully receives and retains the electricity of rain, but also demands at least twice the quantity of manure it formerly did to make it fruitful.

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When in my tenth year—that is, in the winter of the short Peace of 1814–15, I was sent to Nantes with my mother, sisters and brother, and being half way between Nantes and the coast when the Battle of Waterloo was fought, it was determined that we should remain at St. Malo or St. Servan, as being more convenient for my father to come to us occasionally. At that time our garden walls swarmed with the small grey lizard, whilst the small green frog was equally numerous; so plentiful was fruit of all kinds that it was left to rot on the trees. But when I took my family to St. Brieux in 1855, during a residence of seven years I saw but one snake and one green frog, a few frogs and toads, but the small grey lizard had totally disappeared. As to the fruit, the peaches, for example, were ten sous or five pence each, of not one-third the size of those that were sold in about 1820 at 6d. the hundred. In fact, there were no buyers.

Shortly after my return to England in 1822, like most other young men, I paid little or no attention to such matters, but in 1845, having then a correspondence with a gentleman respecting the relative electrical state of the atmosphere and earth, and observing a pair of bright ordinary grocer's scales on the potboard in my kitchen, it occurred to me that, *as electricity was the cause of evaporation*, if I substituted silk for the chains of one of the scales and suspended them in the open air out of all draught on the north side of a wall, they would determine the question, since the one suspended by chains would be connected with the earth by a stout copper wire I attached to the hook in the beam, whilst the other would be insulated from it.

Casually observing the apparatus during October, November, and December, I noticed a very decided excess of evaporation from the insulated vessel, and thereupon decided that the evaporating influence of the atmosphere was much in excess of that of the earth, and so gave the balance no further consideration; but a couple of months later, that is in February, I chanced to see that the excess had been all the other way, a fact that left me no option but to observe the apparatus daily, and so I substituted fine copper wire for the remaining chains, suspended a small dish for weights to the scales, as I had previously done to the insulated one, and made a safe for its safe keeping, and thus imposed on myself the task of registering it night and morning.

Suffice it to say, then, that in 1846, the period of the first potato blight, the air was positive and the earth negative; but a change gradually took place to 1848, when the cholera presented itself to our shores, and fully developed itself in 1849, when the balance gave the immediate opposite information to that of 1846. Now, however, as regards evaporating influence, the earth is quite at a discount and so is agriculture.

With the gradual decrease in the electrical state of the earth, then, have gradually disappeared reptiles and ague, whilst blights, diphtheria, &c., have entered on the stage, diseases of a positive atmosphere that now makes itself felt even in the "lovely month of May," or even June. With such trifles, however, the public are in no way concerned.—Yours, &c.,

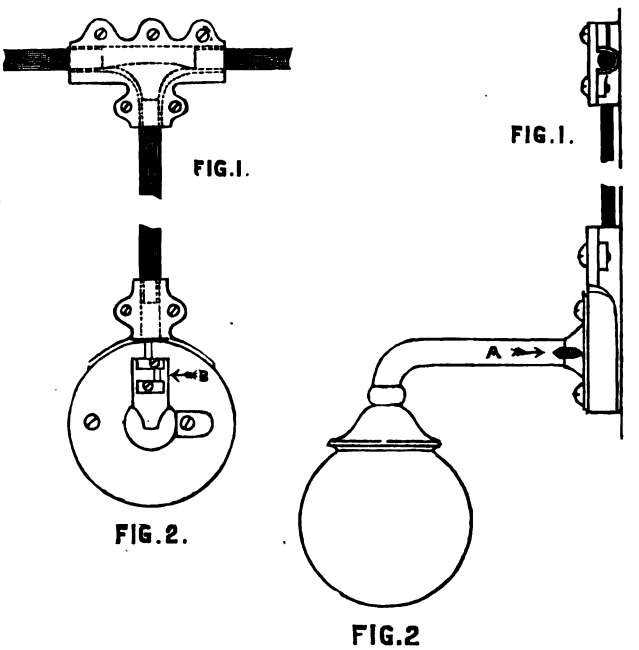
FRANKLIN COXWORTHY,
Author of "Electrical Condition" of 1848.

ELECTRIC LIGHT ON BOARD SS. "UMBRIA" AND "ETRURIA."

Messrs. J. D. F. Andrews and Co., Woodside Electric Works, Glasgow, have just completed on board ss. "Etruria" the last of two installations which, in their proportions, surpass anything that has hitherto been attempted in the application of electric light to steamships.

In the "Umbria" and "Etruria" the installations consist of about 850 lights each, and we append a description of one of the installations, which will, we have no doubt, be interesting to our readers. The description applies to both installations.

The space allotted to the electric machinery is unusually large, measuring 32ft. by 14ft., and is situated on the lower deck, midships, forward of the engine room. Here are placed four Brotherhood engines, two abreast, back to back, three having cylinders 8in. diameter by 6in. stroke, and the other 6in. diameter by 4½in. stroke. The small engine drives a Siemens 200-light machine, and the other three a 350-light dynamo each. Swan glow lamps are used, and of these 90 are distributed in the engine room, stoke holes, &c. The wires conveying the current to these lamps are covered with india rubber and a special composition for resisting sea water, and they are sheathed over all with iron wire, as a substitute for the tube generally used in engine rooms and such places.



The joints between the branch and main wires are protected by a small T shaped joint-box (Figs. 1 and 2). Each lamp in the engine room, as also in every other part of the ship, is fitted with a very simple switch A (Fig. 2). It consists of a screw severing connection to the lamp from the ship, which is used as a return. A fusible connection is also attached to each lamp (B, Fig. 2).

The engine room lights are divided into two circuits, each with a separate switch, and each stoke hole is also on a separate circuit.

The dynamos are connected to the main switchboard on the bulkhead close to the engines. To this switchboard also are brought the six main circuits that supply the ship.

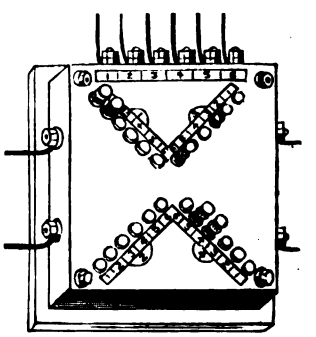


FIG. 3.

The switchboard (Fig. 3) consists of an iron box about 4ft. deep, with its opening against the bulkhead. In the face of the box are four rows of six holes, each 2in. in diameter, radiating from the centre, and the box is half filled with a board of teak wood with corresponding holes. In each of the holes in the teak wood are fixed copper springs, one on each side of the hole, one spring of each hole of a row connected to a brass strap in communication with one of the machines, the other spring being joined to a circuit of lights in the ship.

A brass knob with a stem and an insulated ring at the end

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of the stem is pushed into one of these holes when the machine is to be connected with one of the circuits. The corresponding holes in each circle are joined together, so that by removing the plug from the hole in one position of the row and placing it in the corresponding hole in another the circuit will be joined to another machine. The circuits are numbered, starting from the stem of the ship, the first circuit supplying the night system, in which are about 200 lights, including those in the engine room and stoke holes; No. 2 circuit lights the after portion of the ship; No. 3 lights midships; Nos. 4 and 5 supply the saloon, ladies' saloon, music room, &c.; No. 6 supplies all lights forward of the saloon. Each of these main leads is carried to a group of switches at the junction of the main and branch leads, where there is also a fusible connection. Each of these switches controls a group of about 30 lights, and they are placed in boxes recessed in any convenient places—in passages generally and at the foot of stairs. The switches are constructed of a brass box, and on a similar arrangement to that described as being used in the main switchboard, except that the plug cannot be entirely withdrawn. In appearance this switch resembles the ordinary steam wheel valve (Fig. 4). The main branch fusible con-

The holder is also of new design, although the same as used by this company in their installation on the "Ems" and various other installations. It consists of four spring prongs formed from a brass tube; two of these grip the neck of the lamp, nection, which protects the wires, is a small circular block of wood with a groove across it, in which is laid a piece of lead wire, No. 16 B.W.G., connected at each end to a screw which projects at diametrically opposite sides of the block. The switch and fusible wire are connected together by a loop of wire. The small branch wires lead to the lamps direct without the intervention of other fusible connections, but in the

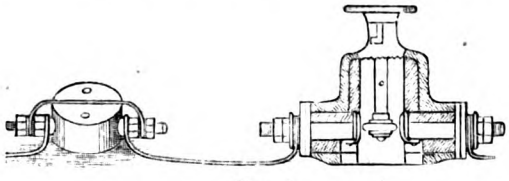

Fig. 4.

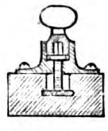

Fig. 5.

back-block of the lamps there is a piece of No. 20 lead wire, which protects the lamps, and also in the event of a defect shows in which lamp it is (Fig. 2).

In addition to the switch inside the room or in the lamp, there is also a switch of the same kind placed in the return wire in the passage, one for each state room (Fig. 5).
which is made of plaster of Paris, knobshaped to suit them. The other two have saucer-shaped ends, and press on brass contacts, held in the plaster. As will be understood, one of the prongs is insulated from the rest by a small piece of wood, forming the body of the holder, the insulated prong being attached to a pin passing through the centre of the wood. The holder is screwed on to the nozzle or nipple of the electric bracket, and in screwing it the pin holding the insulated prong meets with the wire projected from the end of the nipple, thus making contact with the central wire fitting (Figs. 6 and 7).

Altogether 103 lights are used in the lighting of the main dining saloon, 84 of which are suspended over the tables in 3-light electroliers, hanging about 2ft. 6in. from the ceiling (Fig. 8). The remainder of the lamps are in small brackets and pendants (Fig. 6), so as to give light over the side seats. The lighting of the saloon is very effective.

Above the saloon is the music room, having 17 lights round the walls and over the piano and organ. The smoking room has also 17 lamps. The remainder of the lamps are distributed about the ship, 172 being in the state rooms. All the fittings are silver plated, with the exception of those in the galleys, seamen's quarters, and engine room.

On the upper deck, just outside the engine room, is a cast-iron box, containing two switches, and connecting terminals for the Andrews arc lamps. These lamps are of the same design and construction as those adapted to a masthead light on board the North German Lloyd Company's ss. "Ems" and "Eider." The lamp is of great simplicity, and is well suited

Fig. 6.

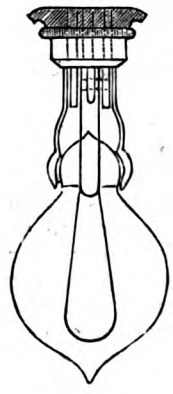

Fig. 7.

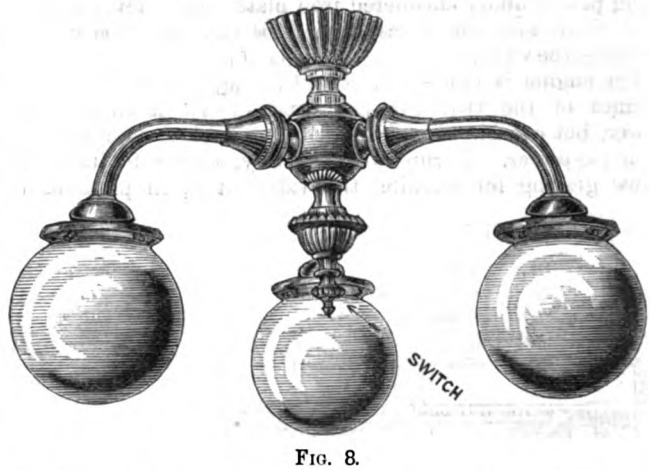

Fig. 8.

for the use of those not well conversant with electrical matters. In this case the lamp is arranged with double carbons. These installations have been carried out in all their details under the personal supervision of Mr. Andrews, who also worked out the various fittings here illustrated.

DOMESTIC ELECTRIC LIGHTING IN NEWCASTLE.

One of the latest examples of the application of electricity to the purpose of the artificial illumination of dwelling houses has just been completed at the residence of Charles Mitchell, Esq. (of Sir W. G. Armstrong, Mitchell and Co.), Jesmond Towers, Newcastle-on-Tyne. The whole of the installation has been arranged and the work carried out by J. H. Holmes and Co., electric light engineers, of the same city.

When the question of the adequate illumination of the building came under consideration, the merits and demerits of the only two systems available—gas and electricity—were carefully compared, and the superiority of the latter became so apparent that it was decided at once to adopt it, and to light the whole of the reception rooms, billiard room, and hall, to the complete exclusion of gas lighting.

It was manifest that, to have perfection, some means of storage must be provided, so that a light might be obtained at any time, whether of the day or night, without the necessity of starting the engine. This was accordingly supplied in the shape of an accumulator, composed of a number of secondary batteries.

With regard to motive power, it was an open question whether a steam or a gas engine should be employed; as the building was to be heated by steam it would only have been necessary to increase the size of the boiler provided for this purpose, but taking into consideration the advantages of the gas engine, its readiness to start at a moment's notice, its free

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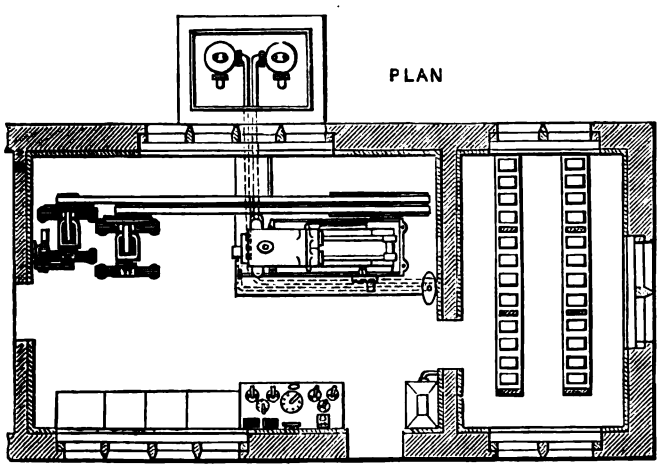
dom from smoke and exhaust steam, and its need of very little attention, it was ultimately decided to make use of this motor.

Owing to peculiarities in the situation, it was necessary that the engine room should be built at a distance of about 100 yards from the house, and the current is carried by means of copper cables placed on insulators fixed to the intervening trees.

Adjoining the engine room, and communicating by a doorway, is placed the accumulator house, in which ample provision for ventilation is secured by windows in three of the walls, and sufficient space allowed for access to both sides of the glass cells to enable a thorough examination of them to be made at any time. The floor of the battery house is composed of asphalte instead of cement, so as to be proof against any acid which might be accidentally spilt upon it, and the pitch pine shelves carrying the cells are coated with a special composition having similar properties, but of more easy application than the bitumen generally used for this purpose. The walls and ceiling are cleaded with wood.

In the engine room special care has been taken to keep pipes, wires, &c., out of sight as much as possible, the former being placed under chequered iron plates let in level with the tiled floor, and the wires carried behind the wood cleading covering the walls.

The engine is one of Messrs. Crossley Brothers' Otto gas engines of the twin cylinder type, of 12 nominal horse-power, but capable of indicating, when worked to its utmost, 25 horse-power. It runs very silently, owing to its having screw gearing for working the valve shaft, in place of the

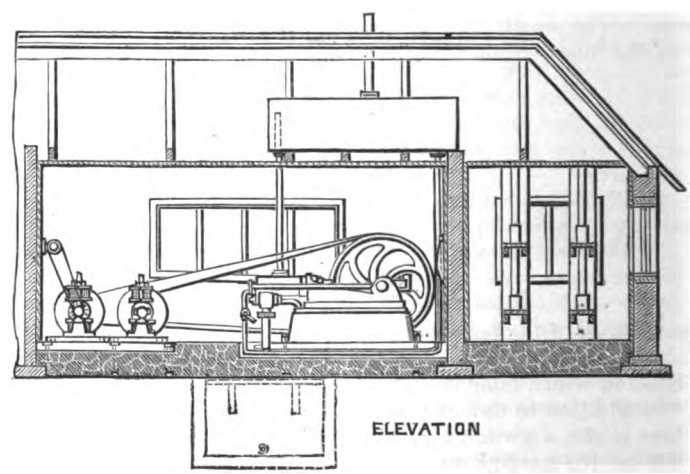


Engine and Battery Sheds.

usual bevel gearing. According to specifications this engine is fitted with Stauffer's lubricators, instead of those of the ordinary type, and the increased economy and cleanliness resulting from the use of solid oil fully justifies this its first application to English gas engines. The water tank, which generally forms such an unsightly object in a gas engine room, is in this instance entirely concealed from view, it taking the shape of a flat tank resting on the roof timbers above the wood ceiling. The hot water pipe is carried in a direct vertical line from the cylinder jacket to the tank above, the return pipe passing down the wall from the other end. Ventilators in the roof provide a current of air for keeping the tank cool, and the steam which otherwise might deposit moisture on the machinery is conducted to the open air through a pipe attached to the lid of the tank. The exhaust pipes are carried through the wall into the cast-iron exhaust boxes, communicating with a chamber below the ground level, from whence the gases find their way to the outer air through an iron grating and two feet of loose stones. By this the usual noise due to the exhaust is done away with.

The fly-wheel of the engine is of a special design, being of extra weight, and the rim turned with a double convex surface for receiving the two endless leather belts, which convey the power direct to the dynamos without the intervention of a countershaft. The dynamos are mounted upon sliding rails fitted with adjusting screws for the purpose of tightening the belts. These machines are of the Siemens vertical type, are shunt wound and each capable of supplying sufficient current for 100 incandescent lamps at 100 volts electromotive force. The dynamos run at a speed of 900 revolutions per minute, and regularity of motion is ensured by heavy fly-wheels attached to the pulleys, and rotating with them. The dynamos were specially built for this installation, and are fitted with brush holders, which may be adjusted to bring the brushes away from the commutator, and thus allow of one dynamo being run merely as a loose pulley; in case the current required is not more than the other dynamo will supply, a small pulley is fitted to the commutator end of one of the machines and drives a tachometer, or speed indicator, placed on a bracket on the wall.

The wires from the dynamos and the secondary batteries are led to a switch-board which takes the form of a horizontal mahogany table 5ft. long by 2ft. 6in. wide. All the connections to the switches are made on the under side, the whole of the front and ends being closed in and panelled. On the switch-board are placed the ammeter, two automatic switches, the starting switch, two dynamo switches, and three ammeter switches; the automatic switches are placed one in each positive wire leading from the dynamos, and serve, by breaking the circuit, to prevent the current from the accumulator running to waste through the machines in the event of their potential falling through accidental stopping of the engine, or any other cause. Three switches are arranged, enabling the current in the battery, or either dynamo circuit, to be shunted through the ammeter for the purpose of measurement. From the last four cells of the battery wires are led to the regulating switch,



which enables the number of cells on circuit to be varied according to the difference of potential desired between the mains.

Although the gas engine is of large size and is not fitted with a self starter, it is easily set in motion by one man; the starting switch consists of a number of resistance coils, which allow the current from the batteries to pass to the dynamos, and to be gradually increased in strength until sufficient to cause the dynamos to revolve, as motors pulling the engine round during the first few explosions.

The storage battery or accumulator used consists of fifty-one cells of the latest type manufactured by the Electrical Power Storage Company, having glass boxes containing thirteen plates each, so that the positive plates, which are smaller, are each of them between two negatives. These cells have, during the three months they have been working, given great satisfaction, and although their discharge current is only thirty amperes, they are capable of regulating the current from the two 100-light dynamos so perfectly as to show no variation at all in the brightness of the lamps.

As before mentioned, the current is carried to the house by covered copper cables suspended overhead to the intervening trees, and then is distributed throughout the house by wires run under the floors or skirting boards. Every branch wire has a proper fusible cut-out, and in many instances these are grouped in brass boxes let in flush with the surface of the skirting board

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and painted to correspond. The whole of the switches used in the installation are of J. H. Holmes' patent "instantaneous break" type, which, it is said, render it impossible to form a dangerous "arc" in breaking the circuit, however slowly the handle may be turned, and are thus safe for use by ordinary persons.

The incandescent lamps used are the "Edison-Swan," requiring an E.M.F. of 100 volts, and ·6 ampere current; they are all arranged in parallel circuit, and are carried by the new "vitrite holders," which answer their purpose well in this the first instance in which they have been practically used.

The most notable feature of the lighting arrangements is the illumination of the picture gallery, a room 75ft. long by 30ft. wide and 25ft. in height. Lamps to the number of 120 are distributed in groups of six lights each round the room at a height of 13ft. from the floor, and are carried by specially designed pendants suspended by means of coloured flexible wire. The room is amply lighted, and the way in which the various colours in the pictures are brought out has been much admired by all who have seen them. The lamps are divided into three sections, controlled by separate switches. Turning to the other apartments, in some of which there are as many as fourteen lamps, we find them grouped on light polished brass electroliers. They are controlled by means of switches placed on the wall of the room just at the door, so that on entering the light may be instantly turned on, and extinguished again on leaving. The billiard table is amply illuminated by six lamps fixed to the old gasolier, the wires are run down inside the gas pipes, and each Swan lamp replaces three of the gas jets previously found necessary. In many of the bed rooms are placed reading lamps, which are quite portable. The electric current is brought to them through very thin flexible silk-covered wire, and the connection is effected by a plug entering a socket fixed to the wall. Such lamps are particularly useful in case of illness, as they give forth abundant light without the usual accompaniments of noxious products of combustion, and enable the invalid to read in bed with comfort.

With regard to the practical working of the apparatus, it need only be said that everything has worked admirably from the first lighting up on December 23rd last; and since that date it has always been possible at any time, whether of the day or night, by the mere turning of a switch handle, to obtain a brilliant, soft, and steady light.

The engine is attended to by the man who fires the boiler that supplies the steam for heating purposes, and during the winter it was found necessary to run the engine an hour or two before dark and continue till about nine o'clock; at the present time, however, the engine is run from three to six, charging the accumulator, which then supplies the ordinary needs in the way of light in the house during the evening. On Saturday the charging is continued for a longer period, so as to store sufficient energy for producing the light on Sunday night, and thus render it unnecessary to start the engine on that day.

THE VAN RYSSELBERGHE SYSTEM OF SIMULTANEOUS TELEGRAPHY AND TELEPHONY.

BY M. CHAS. MOURLON.

Since the first installations of the telephone in the commercial centres of the world it has been seen how admirably the invention of Graham Bell has lent increased facilities to the transactions of commerce and of industry, and it has only remained, in order to enable us to derive the greatest possible benefit from that invention, to extend its use to long-distance communication; not merely from house to house, but from town to town, and from country to country. Some idea has naturally been entertained of utilising the telegraph poles already in existence by placing upon them for purposes of telephonic experiment a wire or wires parallel to those of the telegraph. Directly, however, that is done we find an apparently insurmountable obstacle in the way of success in the shape of "induction," which has the effect of producing in the telephone a frizzling sound, which, for want of a better name, has been called "telephonic frying." These discords, which drown articulation, and render all communication impossible, proceed from the telegraphic currents conveyed by the wires adjoining or in the vicinity of those employed for telephony. It is in effect a reciprocal influence exercised by one conductor upon another, which is parallel to it, and it is governed by the variation of the electric current in the disturbing circuit. Such was the great obstacle opposed in the first instance to long-distance telephony. If these repercussive noises were of such intensity in the circuit of a wire which was merely in the vicinity of a telegraphic conductor, what would have been the result if a telephone had been placed actually in the *circuit* of the telegraphic wire? Could one have dreamed of suppressing the tumult, the deafening uproar which would then have arisen? Nevertheless that is the problem which M. Van Rysselberghe has had the audacity to attempt and to solve. We say audacity, because the difficulties of the problem were not only great, they were numerous.

Having once mastered the induction it was necessary to maintain the secrecy of the telegraph by rendering its signals inaudible in the telephone; it was necessary to prevent the possibility of the telephone intercepting even the smallest portion of any telegram passing by the wire to which it was connected, and it was required to find the means by which the telephonist having the telegraph circuit in his charge should be unable to prejudice that circuit, as by interfering in any way with its conduction or insulation or by putting it to earth. That others have had presented to them the same ideas, and that they have engaged in the discussion of the same problem, before or after M. Van Rysselberghe, it is quite possible. The fact, however, is incontestable that to him alone the honour of its practical solution is due.

The Van Rysselberghe system is based almost solely upon the remarkable fact, discovered by him, that *when the suddeness of the emissions and extinctions of the currents is eliminated those currents become inaudible in the telephone.* For the sudden charges of electricity now in use for telegraphic purposes he substitutes *gradual currents*; that is to say, currents which gradually increase at the commencement and as gradually decrease in strength at the end of each signal. This graduation, which occupies but an infinitesimal portion of time, is obtained by the intercalation in the circuit of small graduating electro-magnets, or, again, by placing upon the line certain condensers which act as derivators, or, finally, by a combination of electro-magnets and condensers absorbing a certain quantity of the current, which they restore on the circuit being broken. Under the influence of the currents graduated in this manner the diaphragm of the telephone is yet subject to movement, but *it no longer vibrates.* The telegraphic current, therefore, produces no *sound* in the telephone. In other words, the telegraphic currents are completely silenced or rendered inaudible whether they be direct, induced, or derived.

By means of this system not only can an effective telephonic service be organised from town to town by utilising the ordinary telegraph poles to carry the telephone wires, but the telegraph wires can themselves be employed for the purpose. The system is one of anti-induction, and completely assures the independence of the two services. It establishes between the telegraph and the telephone circuits a separation of such a kind that, whilst the rapid undulations of the low tension currents of the telephone are readily transmitted, an impassable barrier is opposed to the telegraphic currents, which, it is scarcely necessary to observe, are of an essentially different nature. The greatest beauty of the system is its simplicity, and this will be readily understood upon an inspection of the accompanying diagrams.

In the following Fig. 1, the letters M and R represent respectively the manipulator and receiving instrument of any telegraphic apparatus. P is the battery; E_1 and E_2 are the two graduating electro-magnets, one of which is placed between the battery and the manipulator, and the second between the manipulator and the line L; C is a graduating condenser, placed in derivation upon the line between the two electro-magnets. This condenser, which is of low capacity, is connected on the one side to the line, and on the other side to the

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telephone branch T. By means of this arrangement the telegraph office A and the telephone office B are entirely independent of each other, and are able to employ the same wire for their simultaneous operations, without the slightest interruption resulting to either service.

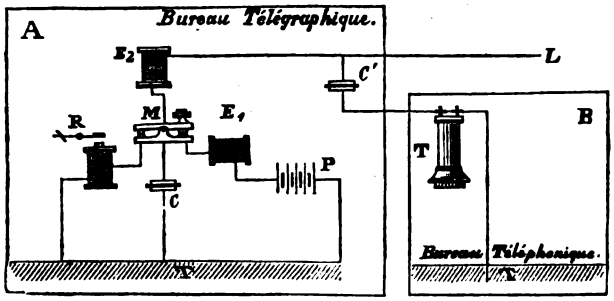

FIG. 1.*

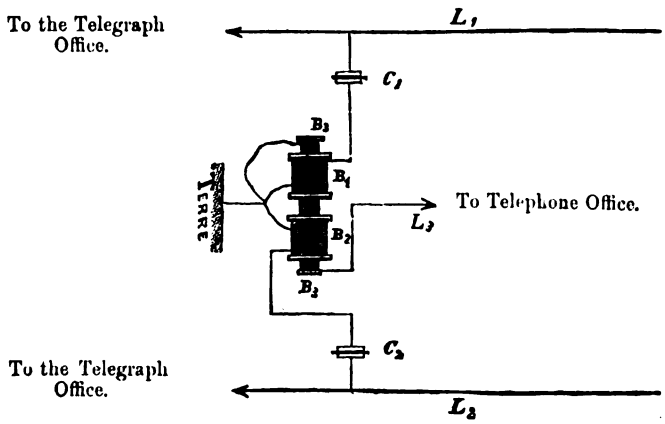

FIG. 2.

Figure 2 represents the arrangements for coupling two distinct telegraph wires, L_1 and L_2, in a complete telephone circuit. C_1 and C_2 are two *condensateurs separateurs* of feeble capacity. B_1 and B_2 are two differential coils, influencing a third coil, B_3; one of the ends of each of these coils is in direct communication with the earth. The other end of B_1 is connected with the telegraph line L_1, B_2 with the line L_2, B_3 with the line L_3, which leads to the central telephone station. From the preceding it will be seen that, contrary to an idea which has been largely entertained, M. Van Rysselberghe has not had recourse to microphones or telephones of special construction for the simultaneous transmission on the same wire of telegrams and of verbal messages. The whole of the adaptation or appropriation necessary takes place in the offices of the telegraph. It is not the telephone but the telegraph which calls for modification, in that the signals of the latter must be silenced. That being done, the dual operation is both possible and practicable with the microphones and telephones in ordinary use. Experience has demonstrated that the apparatus as at present employed enables the voice to be transmitted to more than 100 kilometres (62 miles) of distance; but the results, good, bad, or indifferent, which have been obtained in each particular case have not been the results of experiments with the anti-induction system of M. Van Rysselberghe, nor with his method of simultaneous telephony and telegraphy, they have indicated solely the efficiency of some telephonic services. Independently, however, of the system we have described, M. Van Rysselberghe has closely applied himself to the improvement of the microphone. He has augmented in a great measure the power of his apparatus in a simple but yet effective manner. It is well known that in the carbon transmitters and microphones the electric reproduction of the human voice is due to the variations of resistance which are created in the carbon contacts under the influence of the vibrations which agitate the diaphragm of the microphone. The researches and experiments of M. Van Rysselberghe confirm the hypothesis that *the variations of the resistance of the contacts are of much more relative value, and the variations of the current which result from them are much more considerable when the total resistance of the circuit is more feeble.*

(TO BE CONTINUED.)

* We are indebted to M. Mourlon for the accompanying illustrations.

ELECTRIC CALLS WITH CARBON CONTACTS FOR RAILWAYS.*

The appliances proposed and tried for solving the problem of making and breaking electric contact on the passage of a train have encountered difficulties in actual working, although at first sight the means proposed seemed among the easiest. This question, so important, not only for electric calls and for instruments for measuring the speed of trains, but especially as an integral portion of the block system, whether automatic or not, has been studied in its different phases by the company working the Dutch State Railways.

The first contacts put down, intended to register the speed of trains over large bridges, were established by means of pedals, which were worked direct by the wheels.

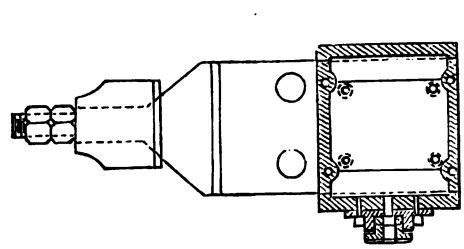

FIG. 1.

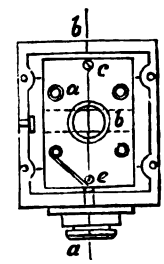

FIG. 2.

The pedal, fixed on a horizontal shaft at right angles to the rail, was depressed by the pressure of the wheels. The shaft made a partial revolution, and, by means of a lever, gave a reciprocating motion to a vertical spindle. This spindle brought into contact two insulated copper springs, which thus set up an electric current supplied by a line battery.

The pedal was again raised by a spring acting in the contrary direction; and this spring, depressed by each wheel on passing, soon got out of order. Moreover, the pedal itself, although of steel, soon became unfit for use.

To avoid shocks, contacts depending on the deflection of the rail were tried, which consisted of a lever, the short arm of which was below the rail, while the pin serving as a fulcrum was carried by a chair attached to an iron bar placed between two sleepers. The long arm transmitted its motion to another lever with unequal arms, and thus made contact.

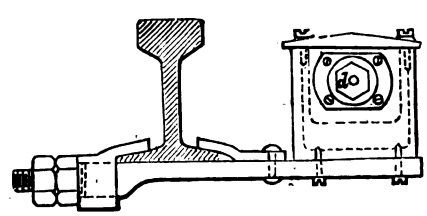

FIG. 3.

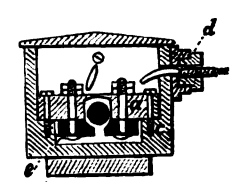

FIG. 4.

These appliances worked well, but they had this great drawback, that they were deranged every time the sleepers were moved. On constructing an appliance independent of these parts, the result obtained was insufficient; and that because the motion of the lever in the first appliances resulted more from the compression of the timber than from the bending of the rail.

Instruments with mercurial contact on the Wiesenthal system gave no better result, because the mercury became oxidised by the sparks caused at each interruption of the current.

Starting from a totally different principle, the company's telegraph inspectors have brought out an apparatus which

* From *L'Electricien*.

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utilises the trepidations of the rail so inconvenient to the other systems.

The arrangement shown by Figs. 1, 2, 3, and 4 represents a cast-iron box, mounted on a wrought-iron plate, which is fixed to the rail by a bolt; in the box, and attached by the screws *c c*, is a piece of ebonite, *a*, in the middle of which is a cylindrical recess, with a copper wire stretched between two screws below it.

Two pieces of carbon, *e e*, are attached to the underside of *a*, there being a space of 1 centimetre (about $\frac{3}{8}$ inch) between the two. A carbon ball rests on the two carbons *e e* in the cylinder *b*.

The insulated wire of a cable, introduced into the box by an aperture in the screw *d*, is connected with one of the carbons, while the other is put in contact with the box, in communication with the earth by the cable covering. In the appliances, which are intercalated in the circuit, two screws, *d*, are used. The second piece of carbon is not connected with earth, but with the second insulated wire.

A battery supplies a permanent current from earth to earth through the carbon contact, so that, when the contact is broken, the current, no longer going to earth, ceases to circulate.

A train passing, and causing the ball to move, owing to the trepidation of the rail, brings about these interruptions of the current, which are registered by a Morse receiver, the paper band of which advances, by means of clock-work, exactly 5 centimetres (2 inches) a minute.

The armature is placed below the coil in such a way that the attraction of the electro raises it. When the current is interrupted, the armature, pulled back by a spring acting in a contrary direction, brings the sugar roller and the paper band into communication.

The sign given by fast trains is a continuous line; and by trains running at a moderate speed, a series of dots.

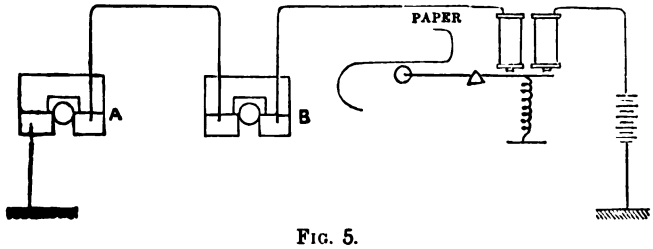

FIG. 5.

Fig. 5 shows the whole installation. The length of paper, unrolled between the commencement of the signs, indicating the passage of the train from A to B, gives the duration of time required to traverse the known distance A B, and consequently the mean speed of the train between these two points.

It should be remarked that, in consequence of the number of cracks in natural charcoal, the use of artificial charcoal is to be preferred.

L. DUFOUR, Engineer, Utrecht.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 423.†)

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9. Views of Pellat.
10. Argument that the Peltier effect does not necessarily measure electromotive force at junctions.
11. Hydraulic illustrations of the difference between Peltier and Volta forces, according to the views of the writer.
12. Summary of condensed statements embodying orthodox views.

7. The result of the survey in regard to our special subject of discussion may be summed up thus:—(1) That there is certainly an E.M.F. at the junction of two different substances, or even of the same substance in two different states; and (2) that the total E.M.F. of a circuit is the algebraic sum of all such contact-forces at every junction in the circuit. I do not know that these two propositions could be passed *nem. con.*, but I believe that, provided they are properly understood, the dissenting minority would be a very small one. It is probable that Prof. Exner would be in the minority, but I am unable to be sure of any one else.

We can also make a negative proposition which will command almost universal assent, viz., that if in the above second proposition, instead of the sum of the contact-forces at *every* junction, we attend only to the contact-forces at the *metallic* junctions, the proposition will no longer be true. This fact, that the metallic junctions are insufficient to account for all the E.M.F., was established by Becquerel, De la Rive, and others, and still more thoroughly and exhaustively by Faraday. It is the easiest possible thing to make a number of batteries which shall give a current without any metallic junction whatever. Faraday gives some thirty of them.*

One more certain proposition we can lay down—viz., that whenever a current is produced, the energy of the current must be maintained by absorption of heat, or by chemical action, or by gravity, or by some other such agent, not by mere contact.

So much being agreed to, what remains of subject-matter for controversy? This: A voltaic circuit contains at least three junctions; what is the value of the contact force at each of them? and especially to which junction is the major part of the observed E.M.F. due? Is it the zinc-acid? or is it the copper-acid? or is it the zinc-copper? There is no other question. The old chemical and contact controversy has died out, but another controversy remains. Most physicists probably would say to-day that the major part of the E.M.F. of the cell resides at the zinc-copper junction. This was Volta's view, and this is the view of the text-book writers taught by Sir William Thomson. Some few would say at the zinc-acid junction, and among them I must confess myself.

It is no question between contact and something else; it is a question between a feeble energy-less metal-metal contact, and an active energetic metal-fluid contact with potentialities of chemical action straining across the junction. What is there to distinguish between the two? Electrostatic experiments with air-condensers prove nothing. They add up three E.M.F.s, air/M + M/M′ + M′/air, and give you the sum. The experimenters usually assume that M/M′ is what they are measuring, but there is no proof to be given in support of the assumption, except that if you substitute water for air the effect remains almost unaltered; but then water contains oxygen as the active element the same as air does. Well, then, it may be urged, the effect is the same *in vacuo* and in hydrogen as in air; and to this I answer, Not proven.

Can any further assertions be made with reference to electroscopic experiments as bearing on voltaic theory? Yes, it can be asserted that by adding up the Volta effects for A/B, for B/C, for C/D . . . and for Z/A, you arrive at the total E.M.F. of the circuit A, B, C . . . . A. True, but what then?

The Volta effect you call A/B is really

$$\text{air/A} + \text{A/B} + \text{B/air};$$

that you call B/C is

$$\text{air/B} + \text{B/C} + \text{C/air};$$

. . . . . .

and that you call Z/A is

$$\text{air/Z} + \text{Z/A} + \text{A/air}.$$

Add them up, and you get

$$\text{A/B} + \text{B/C} + \ldots + \text{Z/A},$$

which *must* be the E.M.F. of a circuit by common sense—*i.e.*, without violent experimental disproof, which no one has ever attempted to give. This fact, that the sum of the Volta effects equals the sum of the true forces, in a closed circuit of any conducting materials, has, nevertheless, caused persons to suppose that air/metal forces are negligibly small. But it is clear that they may have any value they like without affecting the truth of the law. They could only effect it if air/M were not equal to −M/air. The experimental proof of the summation law therefore establishes that air/M *is* equal to −M/air, as well as the important fact that the contact-force at each junction is independent of all other junctions of what kind soever.

8. Leaving electrostatic determinations as without bearing on the point at issue, let us ask, Is there no direct and straightforward way of measuring the actual E.M.F. at a particular junction without disturbance from other junctions? The answer is most clearly given by Clerk Maxwell†, thus:—

"Sir W. Thomson has shown that if Π is the coefficient of Peltier effect or the heat absorbed at the junction by unit current in unit time,

* Reprinted from the *Phil. Mag.* for April.

† Scarcely any of this portion was read at Montreal, but it was given in substance to the Society of Telegraph Engineers on 26th March.

* Exp. Res. ii. 2020. Dr. J. A. Fleming describes another of these batteries in *Phil. Mag.*, June, 1874, and gives some very cogent and readable arguments in favour of the "chemical theory" of battery E.M.F., suggesting that the difference of potential between the terminals of a battery on open circuit is due to potential chemical combination of the metals and electrolytes. He does not, however, explain the old Volta experiment; and, as Prof. Chrystal has pointed out (*Encyc. Brit.*, "Electricity," p. 99), upholders of the chemical theory are bound to explain this.

† "Electricity and Magnetism," vol. i., art. 249. Abbreviated here, because so easy of reference.

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then JΠ is the E.M.F. at that junction acting with the current. This is of great importance, as it is the only method of measuring a local E.M.F.; the ordinary method of connecting up by wires to an electrometer being useless. This Peltier measurement is quite independent of the effect of contact-forces in other parts of the circuit. But the E.M.F. so measured does not account for Volta's force, which is far greater and often opposite. Hence the assumption that the potential of a metal is to be measured by that of the air in contact with it must be erroneous, and the greater part of Volta's E.M.F. must be sought for, not at the junction of the two metals, but at one or both of the surfaces which separate the metals from the air or other medium which forms the third element in the circuit."

And in another place he says* :—

"In a voltaic circuit the sum of the E.M.F.'s from zinc to electrolyte, from electrolyte to copper, and from copper to zinc, is not zero, but is what is called the E.M.F. of the circuit—a measurable quantity. Of these three E.M.F.'s only one can be measured by a legitimate process, that namely from copper to zinc. If we cause an electric current to pass from copper to zinc, the heat generated in the conductor per unit of electricity is a measure of the work done by the current, for no chemical or other change is effected. Part of this heat arises from the work done in overcoming ordinary resistance within the copper and the zinc. This part may be diminished indefinitely by letting the electricity pass very slowly. The remainder of the heat arises from the work done in overcoming the E.M.F. from the zinc to the copper, and the amount of this heat per unit of electricity is a measure of the E.M.F. Now, it is found by thermo-electric experiments that this E.M.F. is exceedingly small at ordinary temperature, being less than a microvolt, and that it is from zinc to copper.† Hence the statement, deduced from experiments in which air is the third medium, that the E.M.F. from copper to zinc is ·75 volt, cannot be correct. In fact, what is really measured is the difference between the potential in air near the surface of copper, and the potential in air near the surface of zinc, the zinc and copper being in contact. The number ·75 is therefore the E.M.F., in volts, of the circuit copper, zinc, air, copper, and is the sum of three E.M.F.'s only one of which has yet been measured."

With every word of Maxwell I cordially agree.

9. While on the theoretical aspect of the subject, it may be well to see what Pellat, as one of the best experimenters on it, has to say. Pellat substantially observes as follows :—

"Does the apparent difference of potential between two metals in contact indicate a real difference of potential between them? In all rigour, No! but the slight variation of its value when different gases or even liquids are used renders it extremely probable that there is such a real difference of potential, and that it is very nearly what is measured in electroscopic experiments."

As to difficulties connected with energy considerations and mere contact, he refers to Helmholtz‡ and Clausius§, who, he says, relieve him of all responsibility on this head.

The fact that the voltaic order of the metals is much the same as their order of oxidizability must have struck nearly everybody, and must also have been felt as a difficulty by the upholders of the efficacy of mere contact. Pellat considers he disposes of it thus :—"Since the E.M.F. of a pile is that represented by chemical action, and since by experiment voltaic contact forces have much the same values as the E.M.F. of piles, it follows that there is some vague relation between A/B and the heats of combination, say of substitution of one metal for another in a salt (as in a Daniell)."

He sums up his experimental conclusions as follows :—

(1) "Two different metals united metallically are covered, in the state of equilibrium, with electric coats of unequal potential."

(2) "This difference of potential only depends on the superficial coat of metal. It changes notably when the surface is mechanically scratched, becoming always more positive. As the scratching effect disappears with time, so does the extra difference of potential. The state of polish of the surface is immaterial, but traces of foreign substances, forming a coat so thin as to be invisible, are able to modify the value of the observed effect enormously."

(3) "The effect depends somewhat on temperature."

(4) "The pressure and nature of the gas surrounding the metals have a very distinct but extremely feeble influence, but, since the effect produced is a lagging one, it is probably due to some secondary cause, and it is probable that the difference of potential is really independent of the gaseous dielectric."

(5) "The difference of potential between the electric coats on two metals united metallically has the same value as the E.M.F. of an element of a liquid pile formed by these two metals, provided that the E.M.F. is determined before any alteration of the metallic surface wetted by the liquid has occurred; but these alterations produce themselves very rapidly."

Pellat's theoretical conclusions being short may also be here quoted, and I will number them on with the others.

(6) "It is extremely probable that the difference of potential between the electric coats which cover two metals connected metallically represents the true difference of potential which exists between them. No reason, either theoretical or experimental, can be invoked against the existence of a difference of potential between two metals in contact."

(7) "This last quantity has no connection with the thermo-electric E.M.F. measured by the Peltier phenomenon."

(8) "It has only a vague and distant connection with the difference of oxidizability of the metals."

Concerning these propositions, I may remark that while number 2 is likely to annoy contact theorists (though I know they have methods of explaining it away), numbers 4 and 5 are calculated to restore their equanimity. The five experimental conclusions I accept as in duty bound, only permitting myself to doubt the perfect generality of numbers 4 and 5 under all circumstances; but the three theoretical ones I am unable to wholly accept. Thus with respect to the second part of number 6, I beg entirely to differ from M. Pellat if I am called on to simultaneously admit number 7. Whether one is prepared to accept any of his theoretical conclusions or to reject them all, depends upon how one regards them. If in the way he himself intended, then I reject them all. If with one's own interpretation, then I say that the second part of 6 and 8 are true (though for "only a vague and distant" I would substitute "no"); and 7 is also true if it be held to refer to the quantity first mentioned in number 6, while number 8 refers to the other quantity. Number 6 I should also consider true if the prefix "im" be made to the fourth word.

10. Pellat then proceeds to explain why he considers the Peltier effect to be quite distinct from, and have no relation to, the true E.M.F. of contact. In explaining this he makes use of a piece of unpleasantly plausible reasoning, which I myself have heard Prof. Ayrton use, and which, when unexpectedly suggested, is so painfully benumbing that it is worth while to quote it, and to indicate its weak point. Pellat's statement of the argument is rather long; perhaps it can with advantage be abbreviated.

Two metals A and B put into contact are at different potentials, the difference A/B being due to and equal to the E.M.F. of contact. There is, then, at the junction not only the contact force E, but also the equal opposite force $-dV$, due to the difference of potential established. Either of these forces alone would resist or aid the passage of electricity across the junction and so give rise to a Peltier effect, but both together will do nothing of the sort; and so if there be any Peltier effect it must be some small residual phenomenon, or it must be due to some other and totally distinct cause.*

Prof. Ayrton's way of putting the argument, which I think he said he got from Sir William Thomson, was something like this. When Q units of electricity are transmitted against a force E, work EQ is done; also when they are transmitted up a difference of potential V′ – V, work Q (V′ – V) is done; but, in an open circuit containing an electromotive junction, V – V′ is produced by and is equal to E. Hence, at an electromotive junction no work need be done by a current; in other words, the existence or non-existence of a Peltier effect has nothing to do with the existence or non-existence of a local E.M.F.

The fallacy of the argument, in either form, lies in over-precise specification of locality; it gratuitously asserts as true for *the junction* what is only proved to be true for the whole circuit. It assumes that there can be no work done *at a junction* if it be perfectly easy to drive electricity either way across it—*i.e.*, if there be no work done *on the whole*.

11. To exhibit the fallacy, consider a hydrostatic analogy. Two vessels of water connected by a pipe in which is a motor of some kind, which, without leakage, exerts a specified force on the water and maintains a constant difference of potentials, but then remains stationary, doing no further work. We typify it feebly in the diagram by an impracticable close-fitting water-wheel driven by a weight without friction.

V – V′ is the equivalent of the force exerted at the junction, and everything is in equilibrium. It is perfectly easy for water to flow from one vessel into the other under the influence of the slightest extra force, for W helps the water up the hill V – V′, when the flow is in that direction; and, whenever the flow is reversed, it lets the water gently down again, taking all its energy out of it. If water is made to flow from A to B, say by pouring more into A, the weight W is lowered, or energy disappears (heat absorbed) at the junction; if it is made to flow from B to A the weight is raised, or energy (say heat) is generated at the junction. Thus there is a true Peltier effect at the junction despite the existence of V – V′ and its equality to the junction force, and yet no resistance is offered to the flow of water either way. Thus is the first form of the argument controverted.

To pump water from A to B by any other pipe would need work to be done equal to Q(V – V′), and to pump water against the force of W, acting alone, would also need work EQ; but when the water goes from A to B *viâ* W, or *vice versâ*, no work is done on the whole. Quite true; but the conclusion that no work is done *at the junction* by no means follows.

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* Maxwell: Letter to *The Electrician*, April 26, 1879. Also "Elem. Electricity," p. 149.

† Further on (sect. 23) I point out that this statement is not quite true, but it does not affect the main argument.

‡ *Die Erhaltung der Kraft*, p. 47, where Helmholtz develops Volta's original hypothesis about an attraction of matter for electricity, of an amount depending on the kind of matter, so that it gets pulled one way or another across a junction of two dissimilar substances. He points out that the Volta effect is explained if zinc be granted a stronger attraction for electricity than copper has. This view he returns to in his Faraday Lecture 1881, where also he refers to Berzelius's electrical theory of chemical affinity. The opinions of Prof. Helmholtz are too weighty to be merely referred to in a footnote, but we may have occasion to consider them later.

§ *Die mechanische Behandlung der Elektricität*, chap. vii. §§ 2 and 3, where Prof. Clausius follows up the above idea by considering the *rôle* which heat plays in the matter, and thus hypothetically explains the Peltier effect also.

* Thus it may be, suggests Pellat, due to a slight difference between E and $-dV$ produced by the mere fact of a current passing; *i.e.*, contact E.M.F. with electricity at rest may be slightly different from what it is with electricity in motion.

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Work *must* be done at the junction in proportion to the force there (by inspection of the diagram); and accordingly the existence or non-existence of a Peltier effect has *everything* to do with the existence or non-existence of a local E.M.F. This controverts the second form of the argument.

If the argument be now considered upset, are we to proceed to assert that the difference of potential, or force, concerned in the Volta effect, and the heat-destruction or generation concerned in the Peltier effect, are closely connected, and in fact different ways of observing the same thing? By no means. All we have proved is that the Peltier effect accurately and necessarily represents and measures the true contact-force at a junction. True we have considered a difference of potential V – V′ as produced by this contact-force in an incomplete circuit; and so it is. But nothing has been said to imply that this difference of potential has anything to do with what is observed in electrostatic experiments as the Volta effect. So far from this, I will assert that what is usually observed when two metals are touched and separated is not primarily a difference of potential between the metals at all. They are at different potentials when separated, no doubt, because they are oppositely charged; but they may have been at the same potential until separated. The real Volta effect is almost independent of the true contact-force, and of the difference of potential which

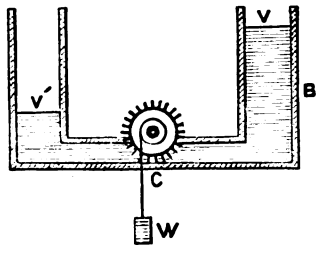

FIG. 14.

Hydrostatic analogue of the true contact or Seebeck force, and of the real though small difference of potential which it maintains between two metals in contact. A and B represent the two metals, C their junction; W is a weight driving a water-tight wheel until stopped by the difference of potential set up. The hydraulic raising or lowering of the weight represents the Peltier effect.

it produces. In other words, a good Volta effect can be observed when there was no difference of potential whatever between the metals when in contact.

According to my view the Volta effect is produced, not by a contact-force at the junction of the two metals, but by a contact-force at their free surfaces, between the metals and the air or other medium surrounding them. To represent this hypothesis by a hydrostatic model, we shall have to maintain the difference of level in the two connected vessels, not by a force at the junction, but by a force at the surfaces; say by using closing vessels and compressed air, or more pictorially by differently stretched elastic membranes or bladders tied over the tops of the vessels.

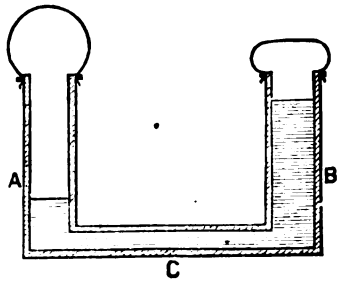

FIG. 15.

Hydrostatic analogue of the Volta effect, or *apparent* difference of potential produced by metallic contact, and of the opposite charges but uniform potential which it maintains between two metals in contact. The vessels are covered by air-tight elastic bags differently stretched.

Note that the difference of level in this case implies no difference of potential; and, as before, no work is required to transfer water between A and B. Hence it is not easy to distinguish this case from the former; and this difficulty of distinguishing between the two cases is what has given rise to most of the confusion. The only easy criterion is the non-existence in the second case of any Peltier effect at the junction C. Naturally it is possible and common for the two effects to be superposed, but they are essentially independent.

Since the two vessels in the second case are at the same potential, the way to observe the effect is to cut and seal the pipe at C, and then show that the vessels are differently charged; which is what Volta did. The model does not indeed represent the gradual change of potential induced as the distance between the condenser plates increases; and it is scarcely worth while to complicate the matter by making a more elaborate model. The thickening of the dielectric layer of a condenser, when its plates are separated, corresponds exactly to the thickening and strengthening of an elastic membrane; and rise of potential in the one case is accurately representable by increase of pressure in the other; but such considerations belong to general electrostatics, and have no special bearing on our present subject.

(TO BE CONTINUED.)

PHYSICAL SOCIETY.

At a meeting of the Physical Society, held on the 28th ultimo, a paper was read by Mr. Joseph Edmondson on "Calculating Machines," which, after discussion, was followed by a paper "On the Structure of Mechanical Models, illustrating some Properties in the Ether," by Professor G. F. FitzGerald.

The author had recently constructed and described before the Royal Society of Dublin a model illustrating certain properties of the ether (*Nature*, March 26). This model was one dimensional, but the author now showed how a tri-dimensional model might be imagined, though probably mechanical difficulties would render its actual construction impossible. Each element of the ether is to be represented by a cube on each edge of which there is a paddle wheel. Thus, on any face of the cube there will be four paddle wheels. Now if any opposite pair of these rotate by different amounts they will tend to pump any liquid in which the whole is immersed into or out of the cube, and if the sides of the cube be elastic there will be a stress which will tend to stop this differential rotation of the wheels. If, however, the other pair rotate by different amounts, they may undo what the first pair do, and thus the stress will depend on the difference between the differential rotations of these opposite pairs of wheels. If η represent the angular rotation of one pair, and ζ that of the other, the stress will depend upon $\frac{d\eta}{dx} - \frac{d\zeta}{dy}$. In order that these four wheels may not similarly work with any other wheel, it is necessary to place diaphragms dividing the cube into six cells, each a pyramid standing on a face of the cube. They must be so made that liquid may not be able to pass from one cell to another through the diaphragm or beside the paddle wheels. To effect this the floats on the paddle wheels would have to be drawn down while passing the diaphragms. Thus the energy of distortion of such a medium would depend upon

$$\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right)^2 + \left(\frac{d\xi}{dz} - \frac{d\zeta}{dx}\right)^2 + \left(\frac{d\eta}{dx} - \frac{d\xi}{dy}\right)^2.$$

And Maxwell has shown that this is also true for the ether. The faces of the cubes should be filled up with diaphragms, past which the paddles should pump liquid, and whose elasticity should be the means of storing electrostatic energy in the medium. The most complicated results follow from supposing the faces of the cubes of which the medium is constructed to have different elasticities. Such a structure represents a crystalline medium and vibrations would be propagated in it according to laws the same as those regulating the transmission of light in crystalline media. If the cubes were twisted the structure would be like that of quartz or other substances rotating the plane of polarisation. To represent magnetic rotation of the plane of polarisation it would be necessary to introduce some mechanism connecting the ether with matter. The author, in conclusion, insisted upon a view which regards the vibrations constituting light to be of the nature of alterations of structure, and not of displacement, executed in a medium possessing the properties of an elastic jelly.

SIXPENNY TELEGRAMS.

The following is an abstract of the correspondence on the above subject which has appeared in *The Times*. It appears to have originated with Mr. Martin J. Sutton, who, having regard to Mr. Shaw-Lefevre's statement that "the name and address of the sender are, except in the most abbreviated form, mere surplusage," pointed out that difficulties were likely to arise under such curtailment. After remarking that nearly the whole of his business correspondence was carried on by wire, he said that:—"I find we have 1,060 customers on our books of the name of 'Smith,' of which number no less than 323 are John Smith; 465 'Jones,' 96 of whom are John Jones; 450 'Browns,' 87 John Brown; other surnames such as 'Williams' and 'Robinson,' joined to other Christian names such as 'Richard' or 'Robert,' showing a similar relative proportion of identical appellations. The name in such cases being of little use alone, the address of the sender is practically the only means by which he can be identified. A country resident's postal address seldom corresponds with or even indicates his nearest telegraph office. The postal address is often the only one with which we are acquainted, and it would not be likely to occur to any one of the 323 'John Smiths' that we had another customer of the same name within 10 miles of him." Mr. Sutton concludes with the refreshing remark that what is wanted is not a lower tariff, but a greater number of country village offices, and suggests that if the Postmaster-General has £180,000 to spare, he had better spend it in extending the area of telegraphic communication. A somewhat lengthy reply to this appeared on the 7th inst. from a correspondent of *The Times*, who, after commenting upon the great extra expense to the Post Office, which will be due to delivery alone, says:—"Telegrams cannot, according to the Post Office statistics, be sent except at considerable cost. The average cost of a telegram now is 10d.; the average receipt 1s. 1d. For 6d. only a much shorter telegram can be sent, if a serious loss is not to be incurred. It has never yet been contended that the telegraph service should be conducted at a loss; in other words, that people who do not telegraph are to pay for those who do. Why should the working man, who, under the present system, probably never sends or receives a telegram from year's end to year's end, and would very rarely despatch one at the reduced charge, pay for the speculator on the Stock Exchange who conducts most of his business by telegraph, or for the bookmaker and his customers, and the racing tout, who are con-

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tinually in correspondence over the public wires? On what system of charge will the public get most benefit from the opportunity of sending 12 words over the telegraphs for 6d.? It is obvious that if free addresses were still to be given, as their average length is 11 words, the Department could not afford to give a message of any appreciable length at all. A text of 5 words would mean a telegram of 16 words in all, and a heavy loss would be inevitable. If the address of the receiver only is sent free, 7 words are found to be average, and thus only 5 words out of 12 would be left for the text—a number which would be still further reduced whenever the sender found it necessary to state his name or address. In all cases in which the sender, in order to say what he wishes, and to give, if necessary, an indication from whom the telegram came, had to telegraph more than 5 words, he must pay more than 6d. Nor would he be able to extend his message by curtailing the address. This is a consideration which should govern the selection of a new tariff. With so high a number as twenty words for the minimum charge, the question hardly arises, as the cases in which it is necessary to exceed the minimum charge are comparatively rare. This is shown conclusively by the low average receipt for a message, 1s. 1d. But when the minimum charge is reduced, and the maximum number of words to be transmitted for it consequently becomes small, it is a matter of moment whether the sender of a message shall have free control over the whole document, or whether the addresses shall be a fixed quantity, the shortening or lengthening of which has no relation to the text. If a man, by using five words in his addresses instead of eleven, can save the Post Office the trouble of sending six useless words, why should he not be allowed to get the benefit of the six words which he saves in the text of his message? Now, when it is found that the average number of words used in addresses in foreign telegrams is five, while in Germany it is only four, it may reasonably be anticipated that English addresses may be shortened as much as foreign when it is to the advantage of the public to shorten them. Yet those who contend for free addresses would prohibit the transfer of the six words of address, whith now, unhappily, burden the Post Office wires, to the text of the message. Because in a few cases it may not be possible to write the necessary addresses in a few words, they would forbid those who correspond with short addresses, or who take the trouble to excise superfluous names, from reaping the advantage in a longer message. It is difficult to see the justice of such a procrustean measure. It is needless to say it costs as much to telegraph a word of an address as a word of a message. The address must be telegraphed to enable the telegram to be delivered, and the telegram is of no use unless it is delivered. There is no reason why a service which is absolutely necessary, and costs money, should be performed gratis. Brevity in telegraphing should, therefore, be encouraged in the interest of the senders of messages. The surest, in fact the only, way to secure brevity is to charge for every word. A system like the present, which allows free scope to prolixity in addresses, and gives so high a limit as 20 words for the minimum charge, is probably as wasteful as any system that could be devised. It is a mistake to think of 6d. as a limit. The proposed change is not the introduction of a 6d. telegram simply, but of telegrams varying in price from 6d. through every penny to 1s. If seven words are not sufficient for the message, or the addresses cannot be compressed into five, another penny will give an additional two words, and for 8d. seven words of address and nine of message, or five of address and eleven of message may be sent. Throughout the whole gamut the possibility of enlarging a message by curtailing the address will apply, if the word rate is adopted; whereas the system of free addresses will give a cramped message, not only at 6d. but for higher sums."

Other correspondents suggest "as an improvement the continuance of free addresses and a halfpenny a word on all telegrams, 6d. being the lowest charge This would allow 12 words instead of eight words, which would add essentially to the value of the boon of the sixpenny telegram and not hurt the revenue; that, in regard to the increased labour, and therefore expense, which will fall upon the Post Office in the delivery of telegrams in consequence of the curtailment of addresses under a word-rate, it is sufficient to say that every foreign State, and every private telegraph company, charges for addresses. That, as to the payment for addresses the case would be met and a leverage used for the economy of words in both message and addresses if the following rule were adopted:—One halfpenny for each word in the message, and half this rate for each word in the addresses of the sender and receiver. No telegram to cost less than 6d., and when excesses of this amount terminate in a farthing, the said farthing to count as a halfpenny. The words could be easily counted, and the telegram stamped accordingly. That, if the proposal now before Parliament to introduce into the postal telegraph system the innovation of reckoning addresses as chargeable portions of a telegram be carried, two things will assuredly happen—we shall lose the benefit of our present admirably-simple, 20-word shilling tariff, and our chances of surprising all but business friends with a real, actual 'sixpenny' telegram will closely approach the proportion of three to 100."

"J. H. B.," thinks that as it is the present practice of the Post Office to charge each figure in a telegram as one word, under the intended change as regards the charge for addresses, some approach to the Continentel mode of charge for figures (five in a group as one word) should be made, or addresses on telegrams to large towns, where the numbering of houses frequently runs into three figures, will become the most expensive part of the sixpenny telegram.

"Compromise" proposes to issue telegram forms with heading only for recipient, and let this be free, allowing sender to designate him or her self in body of message. This would be in assimilation of rule with halfpenny cards, where address of recipient only is permitted on address side.

In a further letter to *The Times* on the 9th inst., "J. H. B." says:—"The arguments of the Post Office in favour of its persistence to depart from free addresses on telegrams are not such as can commend themselves to a practical business country, to whom it is all important to have a simple, uniform principle which encourages no dangerous risks of telegrams being delayed, or, worse still, not delivered at all by reason of imperfect addresses. Senders of telegrams, I believe, most usually only give their own and their correspondent's address, as they would in ordinary letter writing, so that the person addressed may, if need be, at once and without further reference, know where to telegraph or to write in return. Surely the common sense of the responsible chief of the Post Office now sees how strongly the public condemn any change which might endanger the usefulness as well as too rigorously and too dangerously limit the free and full use of what is next to written correspondence, and which is sure to become more and more, under wise and liberal arrangements, a success undreamt of, as it is already a marvel of almost instantaneous intercourse throughout the entire country. The letter of mine advocating free addresses and one uniform tariff of one halfpenny on every word in the body of all telegrams, seems, so far as I have been able to judge, to meet general approval. The safety, usefulness, and simplicity of such a tariff, encouraging free and full expression at small cost, are apparent and likely to benefit and expand the revenue to an extent which neither the ordinary Post Office nor Treasury official has yet dared to dream of."

The *Daily News* states that it is the intention of the Postmaster-General to entirely remodel the printed telegram form. It will probably be, on and after the 1st of August next, something similar to the forms in use upon the Continent, and in which the sender's name will come as a signature to the message with space for his address if he deems it necessary and is willing to pay for it.

Business.—Mr. A. A. Goldston notifies that he has taken over the whole of the plant of the Hammond Electric Light and Power Supply Company in Middlesborough and the surrounding district, and is prepared to give estimates for all kinds of electrical work.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. APRIL 8.		BUSINESS DONE WEEK ENDING APRIL 8. Highest.		Lowest.	
Anglo-American	28,	29	.....	28⅞	.....	—
Do. Preferred	49,	50	.....	—	.....	—
Do. Deferred	6⅛,	6⅞	.....	6⅝	.....	6½
Brazilian Submarine	11,	11¼	.....	11¼	.....	—
Cuba	10⅞,	11¼	.....	—	.....	—
Do. Preference	17,	18	.....	—	.....	—
Direct Spanish	1¼,	2	.....	—	.....	—
Do. Preference	9⅞,	10½	.....	—	.....	—
Direct United States Cable	9¼,	9⅜	.....	9¼	.....	—
Eastern Telegraph	11⅝,	11¾	.....	11¾	.....	11⅝
Do. 6 per Cent. Preference	13½,	14	.....	13⅝	.....	—
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	12⅝,	12⅞	.....	12⅞	.....	12 11-16
German Union	9¼,	9⅜	.....	9⅜	.....	—
Globe Telegraph and Trust	6⅛,	6¼	.....	6⅜	.....	6 9-16
Do. Preference	12⅜,	12⅝	.....	12⅝	.....	12⅜
Great Northern	14,	14½	.....	14½	.....	—
Indo-European	30,	31	.....	—	.....	—
Reuter's	7⅛,	8	.....	—	.....	—
Submarine	175,	185	.....	—	.....	—
West India and Panama	⅝,	¾	.....	—	.....	—
Do. 1st Preference	7½,	7¾	.....	7½	.....	—
Western Brazilian	5½,	6	.....	—	.....	—
Western Union 7 per Cent. 1st Mortgage	120,	125	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	.....	—	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅛,	¼	.....	—	.....	—
Oriental	⅛,	¾	.....	—	.....	—
United Telephone	10½,	11	.....	11	.....	10 15-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞	.....	1⅝	.....	—
Do. (fully paid)	2½,	3½	.....	—	.....	—
Hammond Light (£3 15s. paid)	⅜,	⅝	.....	—	.....	—
Swan	—	—	.....	—	.....	—
Maxim-Weston	3-16,	5-16	.....	—	.....	—

MISCELLANEOUS.

Telegraph Construction	83,	84	.....	83½	.....	—
India Rubber, Gutta Percha, and Telegraph Works	21½,	22½	.....	22½	.....	21½

TRAFFIC RECEIPTS FOR MARCH, 1885.

COMPANIES.	March, 1885.	March, 1884.	Increase.	Decrease.
Brazilian Submarine	2,982	—	—	—
Cuba Submarine	3,500	3,296	204	—
Direct Spanish Telegraph	1,455	1,764	—	309
Eastern Extension	46,193	41,351	4,842	—
Eastern Telegraph	68,296	67,285	1,011	—
Great Northern	23,200	—	—	—
West Coast of America	4,290	—	—	—
Western and Brazilian	2,394	—	—	—

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NOTES.

THE NILE EXPEDITION.—Dal, or Sarkamatto, has been made a telegraph station, and the head-quarters of the line of communication.

THE TASMANIAN TELEGRAPHS.—New post and telegraph offices are about to be erected in Launceston, the estimated cost being about £15,000.

THE BRITISH ELECTRIC LIGHT COMPANY.—A petition for the winding up of the British Electric Light Company is to be heard this day (Saturday).

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 10th April amounted to £3,081.

THE TELEPHONE AND MINES.—In connection with exploring work at the ill-fated Usworth Colliery, the telephone rendered some very valuable assistance.

NEW CABLE.—Telegraphic communication with the Isle of Man is shortly to be improved by the laying of a new and larger cable from Ramsey Bay to St. Bees Head.

ELECTRICAL ATTRACTION.—Some experiments recently made in France show the accumulation of minute particles of dust, &c., on electric light wires to be the result of electrical attraction.

THE ELECTRIC LIGHT IN THE SOUDAN.—The *Daily Telegraph* says:—The electric light has been brought to bear upon the railway works, which will be carried on by night henceforth.

THE ELECTRIC LIGHTING ACT.—Mr. Chamberlain, questioned by Mr. Stanhope, on Monday night, said he did not propose to introduce any Bill this Session to amend the Electric Lighting Act.

CODE TELEGRAMS TO CHINA.—The Imperial Chinese Telegraph Administration notifies that private telegrams written in code are again accepted on the Chinese land lines (Pekin, Tientsin, Hankow, Swatow, Canton, &c.)

THE GREAT NORTHERN TELEGRAPH COMPANY.—This company notify that a telegraph station has been opened at Newchwang, China. Telegrams for that place are now accepted for transmission at the rate of 10s. per word.

AN ELECTRIC MAT.—The Applegate electric mat, covered by an ordinary rug, is a desirable burglar alarm, as the slightest pressure upon it has the effect of ringing an electric bell, and so of calling attention to any nocturnal visitors.

THE ROYAL VISIT TO IRELAND.—On the night of the 15th inst., the ships of the Channel Squadron at Cork were brilliantly illuminated with the electric light, all the merchant vessels and yachts in port also making effective display.

ELECTRIC TRAMWAYS IN AMERICA.—The East Cleveland-street Railway Company of Cleveland, O., is completing arrangements for running the cars of the Euclid-avenue, Cedar-avenue and Garden-street lines with electricity, on the Knight-Bentley system.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 10th inst. were £2,471, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

SALE OF ELECTRICAL APPARATUS.—In our advertisement columns will be found details of the electrical and mechanical plant belonging to the "Pilsen-Joel" and "Electric Lighting Supply and Fitting" Companies, which is about to be sold by public auction.

THE ELECTRIC LIGHT IN FRANCE.—The principal manufacturers in Limoges are now occupying themselves with the question of domestic electric lighting. A committee has been appointed to decide upon the best means to be employed in order to effect their purpose.

THE ELECTRIC LIGHT IN NAPLES.—In connection with the inauguration of the Naples Waterworks on the 23rd inst., we are informed that the waters coming from the Serino will be inaugurated on the 24th, and in the evening the Palace Square and Via Roma will be illuminated by electric light.

NEW CABLE.—A new line of telegraph is being laid between Kirkwall and Tankerness, to be carried direct to Stronsay, thence to Shetland. It is expected that by this new route the cable across Stronsay Firth will have better bottom, and that there will not be such frequent interruptions in future.

CLAIM.—Mr. J. N. Aronson writes to inform us that he patented on the 24th of January, 1882, an incandescent lamp identical with the Perkins lamp described in our issue of the 28th ultimo, and has forwarded us the Patent Office specification. He alleges that the patents of Mr. Perkins date from the latter part of 1883.

THE PROTECTION OF SUBMARINE CABLES.—The Hague correspondent of the *Daily News* telegraphs as follows:—The First Chamber has adopted the International Convention for protecting submarine cables. The Minister for Foreign Affairs promises to do his utmost for the equal protection of cables in territorial waters as in the open sea.

THE LIGHTING OF THE AMERICAN SENATE CHAMBER—The necessary order has not yet been given for lighting the Senate chamber, corridors, and committee rooms by electricity, much to the regret of everybody interested. As the extra session is only for the transaction of executive business, the order cannot be given until Congress re-assembles in December.

THE ANTWERP EXHIBITION.—The Commission of the Antwerp Exhibition will endeavour to establish a unit of price for a unit of work, for each type of machine, and for each kind of application. If this follows as a result of the Exhibition the members of the Commission will be entitled to the thanks of every electrician, and to unlimited kudos at the hands of the public.

THE ELECTRIC LIGHT IN FRANCE—The last installations of the Edison Company are said to be as follow:—New lycée Louis-le-Grand, Paris, 550 lamps; M. Louis Rau, Paris, 40 lamps; Caves de Roquefort (4 installations of 25), 100 lamps; MM. Gillibert et Cie., Marseilles, 200 lamps; M. Schmidt, Havre, 50 lamps; M. Tixerant, Nogent-sur-Seine, 20 lamps; M. Lombard, Arcis-sur-Aube, 50 lamps.

THE INDO-EUROPEAN TELEGRAPH COMPANY.—The directors of this company, at their last meeting, determined, subject to audit, to recommend the payment of a dividend for the six months ended December 31, 1884, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent. for the year, and a bonus of 10s. per share, both free of income tax, making in all 8 per cent for the year.

ELECTRICITY AND WARFARE.—It has been determined by the Admiralty that not only the armour-plated ships, but the whole of the other vessels to be despatched from Chatham

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shall be supplied with electrical arrangements for discharging the machine and other guns. All the turret armour-plated vessels, as well as some of the largest of the other ships, will have the electric light fitted on board before they leave Chatham.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.—The next ordinary general meeting of this society will be held at the Institution of Civil Engineers, on Thursday, April 23, at 8 p.m., when a discussion on Prof. Oliver Lodge's paper on "The Seat of Electromotive Force in a Voltaic Cell," will take place, and a paper on "Electrical Definitions, Nomenclature, and Notation," by Andrew Jamieson, F.R.S.E., member, will be read.

THE GREAT NORTHERN TELEGRAPH COMPANY OF COPENHAGEN.—The total receipts of this company last year, including the balance brought down, were £324,662 1s. 3d., and the expenses, including debenture interest and amortisation, £112,657 9s. 6d. Out of the surplus, dividends of 5 per cent. and 3 per cent. respectively have been paid, absorbing £120,833 6s. 8d.; £55,555 11s. 1d. is added to the reserve and renewal fund, and the sum of £31,337 18s. 5d. is carried forward.

NEW PROPRIETARY.—A prospectus is issued of the Varley Electric Patents Proprietary, with a capital of £40,000, of which £12,500 are allotted in the form of fully paid-up shares to the vendors. In addition to this, £4,560 in debentures not bearing interest, but falling due for payment at intervals over a period of six years, have been issued in payment for plant and stock. The patents relate to rigid and flexible carbons, storage and regenerative batteries, electric meters, dynamos, and arc and incandescent lamps, electro-chemical, and other filters, &c.

SIXPENNY TELEGRAMS.—Mr. Stuart-Wortley, M.P., on the second reading of the Telegraph Acts Amendment Bill, will move, that "A State Department, enjoying a monopoly of inland telegraphic communication, and liable practically to no penalty for the misdelivery of messages, is not, in the opinion of this House, justified in proposing to so adjust its tariff as to discourage the full statement of all particulars reasonably necessary for the identification of the persons to whom, and the place at which, it contracts to deliver the messages which it receives for transmission."

ELECTRIC LIGHTING IN THE NAVY.—In addition to the gunboats mentioned last week as being supplied with the machinery requisite for producing electric light, the following ships have also to be furnished with dynamos and engines for this purpose, viz.—H.M.S. "Orion," fitting at Deptford, H.M.S. "Inconstant," fitting at Devonport, "H.M.S. "Nelson," "Rupert," and "Invincible," fitting at Portsmouth. The Victoria dynamos for the above ships are being actively pressed forward by the Anglo-American Brush Electric Light Corporation, to whom the contract for the work has been entrusted by the Admiralty.

ELECTRIC LIGHTING AT LEEDS.—At a recent meeting of the Leeds Town Council, the chairman of the Electric Lighting Committee, in moving the confirmation of the minutes, stated that the committee had been very badly treated by the contractors, and that their case would be disclosed in a court of law. The town clerk, replying to a question, said he had that morning been served with a writ on behalf of the Corporation. The contractors sought to recover a balance which they allege to be due; but as this now formed the subject of litigation, it would not be advisable to make any remarks upon the facts.

PROGRESS IN GERMANY.—During the past six years dynamos to the number of 6,000 have been constructed in the different workshops in Germany, representing a value of £700,000. The number of arc lamps made during the same period was 20,000, realising £250,000. In the four years, 1880 to 1884, the number of telegraph offices open to the public rose from 5,114 to 7,529, and the mileage of the wires from 121,520 to 150,040 miles. The telephone was introduced into Germany in 1880; there are to-day 58 country exchanges, having 7,311 subscribers, and possessing a network of wires extending over a distance of 10,100 miles.

THE ELECTRIC LIGHT AT WASHINGTON, U.S.A.—The United States Electric Light Company have put up eight of their arc lights in front of the executive mansion at Washington, U.S.A. The wires were laid in underground cables, and led up through the posts so as to be entirely invisible. The effect was excellent, and afforded so much satisfaction that an order has been given for a continuance of the lighting in place of the gas lamps by which the approaches to the mansion have been lighted. The incandescent lights for the interior department have been put in by this company, and also give much satisfaction.

THE BREAKDOWN OF H.M.S. "MONARCH."—When it became evident that this ship could not make Malta without a serious accident to her machinery, it was decided, we are informed, to stop the engines and await arrival of a passing steamer, which might tow or render other assistance, the distance from Malta being about 250 miles. Although the "Monarch" burnt the electric light at her masthead and sent up rockets all night, it was not until the following day that she was sighted by the steamship "Hampshire." Had it not been for the valuable assistance of the electric light the succour of which she was in need might have been still further delayed.

SIMULTANEOUS TELEPHONY AND TELEGRAPHY.—The French Minister of Posts and Telegraphs has lately organised a series of experiments of simultaneous telegraphy and telephony upon the subterranean cables which connect Beauvais with Paris. The distance is about 100 kilometres (62 miles), and the results are said to have been in every way satisfactory. The apparatus employed during the experiments was that of M. Louis Maiche. These experiments, says our contemporary *Cosmos*, are of great importance from the fact that they are the first which have been made, subsequent to those between Paris and Versailles, Paris and Morat, Paris and Meaux, upon subterranean cables of such a length.

THE CENTRAL ASIAN TELEGRAPH.—Mr. Charles Marvin learns from the semi-official *Karkaz* of Tiflis particulars of the laying of the Central Asian telegraph. At the present moment the telegraph from Askabad to Merv, *via* Sarakhs, is already constructed and in full working order. Consequently, the telegraph extends from St. Petersburg to Merv, from whence couriers could carry messages to General Komaroff in less than a day. In regard to this subject we may mention that four months ago, namely, in our issue of the 10th of January, we announced the contemplated immediate erection of a line of telegraph from Askabad to Merv and Sarakhs, and the week following, the *Standard's* Teheran correspondent telegraphed that the Russians were then erecting the line from Askabad to Merv.

THE BIDWELL ELECTRIC RAILWAY.—The officers of the Bidwell Electric Railway Company have given an exhibition

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of their new motor at Philadelphia, U.S.A. A track was laid around the room 250ft. in length, and a car capable of holding 10 persons was placed upon it. The motive power was furnished by a 5 horse-power dynamo. This also furnished several incandescent lamps in the car, and some large lights along the track. The same current also heats the car. By an arrangement which is attached to the car, salt or a chemical compound can be fed to the track in cold weather to keep it clear of ice or snow, and dirt is swept out by a brush which is also attached. The experiments are said to have been "quite successful." We should think so, indeed. But why does not it also get up steam and heat its own boiler?

SIXPENNY TELEGRAMS.—Lord J. Manners gave notice on Monday night that, on the second reading of the Telegraph Acts Amendment Bill, he would move "That in the opinion of this House it is expedient in any arrangement of the charges for the transmission of inland telegrams to retain the system of free addresses which was established by the Telegraphs Act." The *Standard* states that there is every probability that Lord John Manners' Amendment will be carried. In that event the Postmaster-General will abandon the Bill, and the introduction of cheap telegrams will be postponed for a year. As the sixpenny telegrams would have involved a considerable sacrifice of revenue, the Chancellor of the Exchequer will not, under present circumstances, regret the postponement of their introducfion for twelve months.

ELECTRIC LIGHTING OF A DINNER TABLE.—A correspondent informs us that at the Highland and Agricultural Society's Spring Flower Show held in Edinburgh last week there was a unique display of electric lighting of a dinner table *a la Russe* by Messrs. Jenkinson, of Princes-street. The candelabra and centre piece, being of china from which the lamps hung, decorated with flowers, presented a very artistic appearance. Round the table at intervals were growing plants, with a glow lamp in the centre of each, which produced quite a novel effect. The whole presented a fairy-like *coup d' oeil*. All wire on the table was completely hidden by green foliage. The current was supplied from accumulators underneath the table. The ornaments were specially manufactured for use with the electric light, the whole of the arrangements being carried out by Mr. James Gibson, of Edinburgh.

THE OVERHEAD WIRES COMMITTEE.—On Thursday the Select Committee of the House of Commons, under the presidency of Mr. G. W. Russell, to inquire into the law controlling telephone and telegraph wires, resumed its sitting for the first time after the Easter recess. Mr. Johnson, the chairman of the Commissioners of Sewers, was first examined. He said that, if it were possible, all the wires should be put underground, but the difficulties were very great, if not insurmountable, especially in the matter of expense. That might be met in the first place by loan, so that the cost of subways might be met. He did not advocate this, but he thought the companies might recoup themselves by rentals. If all the directions were given in an Act of Parliament there would be no difficulty in local authorities controlling the wires. There should, he thought, be an appeal to a department of the Government.

THE ELECTRIC LIGHTING ACT.—Commenting upon this question, the *Pall Mall Gazette* says:—"There is to be no Electric Lighting Amendment Bill this year, and for the very good reason that Parliament has already quite as much as it can do in the few months that remain to it. The Committee of Electric Lighting Companies, in the draft Amendment Bill which they have submitted to Mr. Chamberlain, have raised some knotty questions, which, in the interest of the public, should not be settled hastily by a moribund Parliament. Broadly, there is not an important clause in the Electric Lighting Act the reconstruction of which has not been very fairly demanded by electricians, and the ultimate settlement of the question will probably be arrived at by steering a middle course between the Act and the draft Amendment Bill. Meanwhile, electricians may very profitably devote their best energies to the invention of a serviceable meter."

PREPARING FOR WAR.—Additional supplies of torpedoes are being sent to the naval stations at home and abroad, and also to the officers in charge of the coast districts. These torpedoes are of the stationary or submarine order, to be used for the defence of harbours and the entrances of rivers, and fired by electricity from the shore, to which, when touched by a passing vessel, they transmit automatically a vibratory signal. To this class, and the Whitehead, or fish torpedo, it is proposed to add a third, being a newly-designed electric torpedo, which is easily steered by electricity from the shore, and travels in the shape of a submerged boat to the attack of a hostile ship a mile or more away. Experiments are now being made with this torpedo, under the direction of the inventor, at one of the dockyards, and some marvellous results have been obtained; but, like other torpedoes which are allowed a certain freedom of action, this one has exhibited an unfortunate disposition to plunge downwards into the mud. Provision is now being made to counteract this tendency, and the electric torpedo is undoubtedly destined to be one of the most dreaded of its family.

OUR TELEGRAPHIC COMMUNICATION WITH THE EAST.—The following resolution has been passed by the Council of the London Chamber of Commerce and forwarded to Her Majesty's Secretaries of State for Foreign Affairs and the Colonies, and the Chancellor of the Exchequer:—"That, in view of the great inportance of British mercantile interests in the East, more particularly as concentrated at Hong Kong—the shipping tonnage of which entered and cleared in 1883 amounted to 6,882,000 tons, the yearly imports and exports exceeding £4,000,000 sterling—strong representations be made to the Government as to the imperative necessity of protecting British interests in the China Seas by adequate defensive precautions both at Hong Kong and Singapore; and that these two important ports should be without delay united by a direct submarine telegraph cable entirely in British hands, even if a small Imperial subsidy (as in other cases) be requisite to ensure its being laid." This action was taken on receipt of a telegraphic communication from Hong Kong notifying the decision of the Legislative Council in the same direction, and urging the London Chamber to support.

A DARING ACT.—A daring act was performed recently (says the Melbourne *Age*) at Griffith's Point by a telegraph line repairer named Charles Sharp. The telegraph wire which crosses the eastern entrance to Western Port Bay is fixed on two tall poles 160ft. in height. At the base they are 9ft. in diameter; hence it is impossible to climb to the top by the ordinary method. An iron pulley was, therefore, fitted to the poles 110ft. from the ground. By means of a wire running through the pulley a person could be raised to a point where the diameter was small enough to allow a man to clasp it with his arms. The wire broke recently, and Sharp essayed to climb the pole with a new wire and reeve it through the pulley. He fixed two long sharp spikes to his feet and commenced his perilous ascent, which was made by forcing one spike into the pole and raising the other leg a step higher. Owing to the immense girth of the pole he was, however,

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unable to get a good hold. Notwithstanding this he reached the pulley and descended by means of the wire he had carried up. Had Sharp lost his presence of mind for one moment he would have been dashed to pieces on the rocks below.

A NEW CHANDELIER FOR ELECTRIC LIGHTS.—A new chandelier, designed by M. Clariot, has been introduced in the Magasins of the Louvre in Paris, in connection with the Jablochkoff candles employed to light those premises. The apparatus consists of a platform of marble, in the centre of which is disposed a metallic piece communicating on one side with one of the poles of the machine generating the current, and on the other with one of the chandeliers of each pair of candles. The other chandelier carries a small piece of wire fixed to a drop of solder, which latter, upon being fused, fills the office of the commutator. There are four pairs of candles, each pair having a separate metallic piece arranged on the other side of the platform. These pieces are insulated from each other. The small piece of wire is fixed upon the bar of metal carrying each pair of candles in such a manner that by keeping a spring compressed it prevents the candles from being lifted into position and lighted. In that case, only one pair, that in connection with the central plate, can be in action. When, however, it is wished to add to the number, it is only necessary to effect the fusion of the drops of solder, which releasing the spring in each particular instance, put as many pairs of candles as may be desired into circuit.

MOTIVE POWERS.—A correspondent of the Manchester *Examiner* writes as follows:—The proposal to levy a tax upon coal would greatly injure many dependent industries, without creating other industries. I think two very important uses to which coal has been put may now be supplied from other sources. We have it now in our power to dispense with coal for motive power and lighting purposes. The electric light may now supplant gas light, and motive power may be had from electricity in running our mills and workshops. In fact there is now no necessity for coal except for heating purposes. We have a large storage of power in our reservoirs which can be illimitably increased. I would suggest that an exhibition of water motive power and electricity be held in Manchester, and also that diagrams of the country be exhibited showing the best watersheds where water can be extensively stored. I have often desired to utilise the town's water for the purpose of turning machinery by a water engine, but I am prohibited through the excessive charges. I have often inquired if there were any exhibitions of water and electric motive power, but no one knows. I hope our Manchester friends will get up an exhibition, which I am sure will be largely patronised. It will create other industries and utilise an inexhaustive source of power.

ELECTRICITY AND MINES.—The mines of Marles, near Béthune (Pas-de-Calais), offer an example of the numerous applications to which electricity readily lends itself. The mines are not only lighted by the fluid, they possess a telephone system, an electric signalling apparatus, and other equally useful installations. The lighting is effected by 60 Edison incandescent lamps in the buildings and offices, and four arc lamps, of 32 candle-power, placed at the shafts. The signalling apparatus is at the bottom of the mine, and replaces the ancient system of communication by cords or rods, which were uncertain and irregular in their action. The different telephone stations, numbering three to each shaft, are connected by a network of conductors, arranged in such a manner that the signal assures the sender of the faithful transmission of his call. This signal is given by a needle which indicates upon a graduated dial the nature of the signal given, while attention is called by a bell of the ordinary pattern. These arrangements are said to so economise time that ten tons of material can be raised in excess of that found to be possible with the old system. In order to ensure the proper working of the ventilators in the subterranean passages there is also an electric tell-tale, which shows the number of revolutions made by each fan in a given time. The whole of the installations have been put down by Breguet, under the direction of M. Thiry, the chief engineer of the company.

ELECTRIC LIGHTING OF THE "ANGELO."—This fine steamer, of the Wilson line, regularly engaged in the mail and passenger service between Hull and Christiania, was on Tuesday taken down the Humber for a trial run, having recently undergone very extensive improvements. One of the greatest improvements effected from the passenger's point of view will be the introduction of the electric light. In every part of the vessel, including the masthead and side lights, this modern means of lighting has been introduced. Altogether there are 120 lights, eight of which are in the dining saloon, which is amidships on deck, whilst the drawing room saloon is also fully lighted. From stem to stern the 'tween decks are lighted for the accommodation of the emigrants, and the same kind of lighting has been supplied for the engine room, and even the stoke hole. The fittings have been placed on board by Mr. T. Muse, who has been engaged by Messrs. Thomas Wilson, Sons, and Co., as their electrical engineer. Electricity is generated by one of Paterson and Cooper's Phœnix dynamo machines, and the lamps are the Edison-Swan. The masthead and side lights are fitted with the Bernstein incandescent lamp. The engine to drive the dynamo has been supplied by Messrs. Rose, Downs, and Thompson, and it has been fixed on the first platform of the engine room. Motive power is supplied from the main boilers when at sea, and by the donkey boiler when in harbour. The masthead and side lights have been designed by Mr. Muse, and manufactured by Messrs. Whitfield and Hakes, Commercial-road, Hull. All the fittings have been made locally by Messrs. J. Clark and Son or by Messrs. Whitfield and Hakes.

AFRICAN CABLES.—We notice with considerable surprise that a meeting has been held, under the presidency of Baron Grant, as a public protest against interruptions of the cable service to South Africa. It may be taken for granted that the promoters of this meeting imagine that all communication is intended for their own special benefit, and also that the various natural forces at the bottom of the sea can be rendered nugatory so far as the cable they specially desire to use is concerned. Those, however, who have had experience in cable matters know that however careful survey has been, it is absolutely impossible to guarantee that the cable is laid in harmless waters. One section of the South African cable has been rendered useless from time to time from natural causes which no experience, no amount of expenditure, no constant scrutiny could ward off. The company owning this cable has long since decided to duplicate this particular section, and to thus endeavour to obviate this rupture of communication. The cable for this work is, we believe, almost wholly manufactured, and the duplicate section will be on its way to the coast of Africa in a few days. What Baron Grant and his co-agitators can expect of a commercial company it is difficult for us to say. In the first place, the directors of such a company have to provide interest upon the capital entrusted to them by the shareholders, and in order to do this they cannot undertake the duplication of cables unless it is absolutely necessary, or unless the business transacted is sufficient

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to warrant the expenditure. It is an easy thing to say cables ought to be kept in thorough repair, but those who have the control of the cables know that it is extremely difficult to keep them so.

THE ELECTRIC LIGHT AND THE SUEZ CANAL COMMISSION.—The *Standard* is informed that at the last meeting of the Grand Technical Commission one of the members observed that the sub-commission that had been charged to go to the Isthmus of Suez to study on the spot the improvements required had not in its report made any mention of the navigation of the canal at night by means of the electric light. This question was, he knew, under serious consideration, and he thought it right that in the report of the proceedings of the commission mention should be made of this important question of night navigation, which was calculated, when realised, to so materially shorten the time passed by most ships in the canal. The answer given in the name of the sub-commission was that it had only wished to declare that, in accord with the opinion of the captains and pilots, a vessel, even when obliged to spend a night in the canal, would, when the improvement works were completed, get through the canal in 24 hours. The sub-commission had not been charged to study the subject of lighting, but it had, nevertheless, witnessed experiments of night navigation of the canal by means of the electric light, established on a tug steamer. The experiments took place on the canal, between Suez and Ismailia, and their result is given in the report in the following words :—"Unfortunately, the experiment was made on a moonlight night—that is to say, the effect of the electric light was attenuated. On the portion of the canal where it was made, comprising the few miles which precede the arrival at Lake Timsah, the navigable channel is buoyed with pairs of buoys (one red and one black) at intervals of 500 metres. The electric light always enabled one pair of buoys to be kept in sight, but it was scarcely before the tug had arrived at a pair of buoys that another pair became distinctly visible ahead. Under the conditions in which the experiment was made it would have been necessary to have pairs of buoys placed at half their present distance from one another, as for steering it is requisite always to have two pairs in sight."

OVERHEAD WIRES.—A correspondent of the *Pall Mall Gazette*, writes as follows :—"I am credibly informed that between 150 and 200 overhead wires broke in London during the last slight snowstorm. Had the snow frozen as it fell, not a galvanized wire in London would have been left hanging. What loss to life and property this means may be gathered from the fact that one company stated in a law case some time back that it had 10,000 miles of overhead wires in London alone. In a storm in Aberdeen last month the telephone system was much interfered with, and the papers say that wires were dangling in all directions. At Portsmouth the other Sunday the snow broke numbers of wires and snapped some of the iron telephone posts. At Notting-hill the weight of the snow drove an iron telephone 'chair,' or support for several wires, through the roof of a house. Some years ago a wire in falling decapitated a horse in Oxford-street, and another killed a man in Manchester. At a fire in Oldham an escape 36ft. high caught in some telephone wires, which dislodged a lot of masonry and hurled it among the crowd, seriously injuring several persons. Notwithstanding such occurrences the United Telephone Company is at present applying to Parliament for compulsory powers to suspend overhead wires within 3ft. of roofs, or 15ft. of the surface of roads, without the consent of those interested or any compensation to them, either for the original invasion of their rights of property or for the loss they may suffer through the wires falling in storms. Telephonic communication is in its infancy and will increase a hundredfold. It is absolutely essential in the public interest that the wires should be carried underground. The cost is a matter for the telephone companies, but as the subscription in London to their exchanges is three or four times as much as in many large cities, they could probably well afford the expenditure. The wires are carried in the sewers in Paris." This statement, as far as it relates to the number of wires broken and injury done, has since been contradicted. The communication, however, remains substantially as given.

SUGAR REFINING BY ELECTRICITY.—Some further particulars of this remarkable process of sugar refining appear in our contemporary, the *Grocer*. For the exploitation of the scheme a new company has been formed, with a capital of 1,000,000dols. This undertaking is entitled the "Electric Sugar Refining Company," their offices being at 47, King William-street, New York. Mr. R. N. Woodworth is the president, and Mr. H. Belden, of the National Park Bank, New York, is the secretary. The system of manufacture is supposed to be a profound secret, the only persons now engaged in carrying out the invention being at work with closed doors, and nothing on a large scale will be attempted until all the arrangements are completed. The company, it is said, owns the invention of Henry C. Friend, of New York, and its exclusive use for the whole world. This invention is an entirely new process of refining sugars; it is dry throughout, dispensing altogether with boiling and the use of bone-black. No syrup whatever is produced, but the whole product is hard sugar of nearly, if not quite, absolute purity, namely, 100 per cent. cane sugar, as per analysis. A principal feature of the process is the use of electricity, concerning which the inventor claims he has discovered a new manner of producing it at a nominal cost. He claims, and is said to have proved, the following points (the demonstrations he has made have been with parcels of sugar from 10lb. in weight up to over 2,300lb., and the qualities of the raw sugars refined have been various, including beetroot, second quality, Java stroops, and such low grades) :—The process of conversion does not take, in point of time, more than four hours; and the production once commenced, the output of the refined sugar is continuous so long as the raw material is supplied. The cost of the process will not exceed 80 cents per ton—this being the price arranged by contract with Professor Friend, to the performance of which he pledges all his interest in the company; and the product upon analysis will show not less than 99·50 per cent. of pure sugar. Any description of refined sugar can be produced, from the finest powdered up to and including cut and pressed loaf; and the profit in the working of this process will be not less than £5 per ton of 2,240lb. The cost of the machinery required to produce at the rate of 4,000 barrels of refined sugar per day of twenty-four working hours, together with the power requisite to run the machinery, and all the attendant apparatus for handling it up to the point of its being put into barrels, and the fitting of a suitable building to receive and work the machinery, is estimated not to exceed £20,000. This discovery in sugar refining has naturally aroused a deal of curiosity and inquiry. Already three members of well-known firms of sugar refiners at Liverpool have, we are informed, started for New York to inquire specially into the whole matter on the spot, and bring back here authentic and trustworthy reports of the entire scheme.

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ALTERNATING CURRENTS.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 412.)

The cases already considered of a circuit bridged over at one or more pairs of points by condensers have not included the more complicated systems in which self-induction exists in any of the sections of the conductor. In practice a coefficient of self-induction would always exist in the section including the generator, and might be introduced into any of the other sections with the instruments inserted into them. It is therefore desirable to know what effect it would have upon the currents of the system. The general case may be represented by the following:—

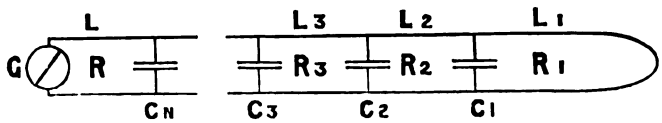

FIG. 10.

Here $C_1, C_2, C_3, \ldots C_n$, represent the capacities of the condensers, beginning from the remote end of the circuit,

$R_1, R_2, R_3, \ldots R_n$, R, the resistances of the sections.

$L_1, L_2, L_3, \ldots L_n$, L, the coefficients of self-induction of the sections, in the same order.

G represents the generator of the harmonically varying E.M.F.

Let T be half the period as usual.

To construct the proper diagram of electromotive forces, proceed as follows:—

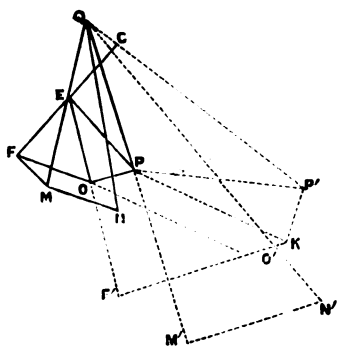

FIG. 11.

Take any line E C to represent the effective E.M.F. in the section R_1.

Set off the angle C E Q in the direction of advancement, such that $\tan CEQ = \frac{L_1 \pi}{T R_1}$, and draw C Q perpendicular to E C.

Produce Q E to M, so that, Q E : E M :: R_1 : R_2.

At Q set off the angle M Q N in the direction of advancement, such that $\tan MQN = \frac{C_1 \pi R_1 R_2}{T R_1 + R_2}$, and draw M N at right angles to Q M.

Draw M F at right angles to C E produced, and cutting it in F, thus making the two triangles, C E Q, F E M, similar.

From F draw F O parallel and equal to M N, and in the same direction as that line.

Join O E, and at E set off the angle O E P in the direction of advancement, such that $\tan OEP = \frac{L_2 \pi}{T R_2}$; draw O P perpendicular to E O, and join P Q.

Then P Q is the E.M.F. of the condenser C_2, or if there be but one condenser, it will be the E.M.F. of the generator.

E Q is the E.M.F. of the condenser C_1,

O E is the effective E M.F. in the section R_2,

and E C, by hypothesis, that in the section R_1.

These points are proved as follows:—

Since E C is the effective E.M.F. in R_1, which possesses a coefficient of self-induction L_1, the impressed E.M.F. of this section must be such an E.M.F. as has its phase and magnitude determined as E Q has been obtained from E C, *i.e.*, it must be the hypothenuse of a right-angled triangle having the effective E.M.F. for a base, and the angle between the base and hypothenuse such that its tangent is equal to $\frac{L_1 \pi}{T R_1}$, and this angle must be in the direction of advancement from the base.

Hence E Q is the E.M.F. of the condenser C_1.

Since Q E : E M :: R_1 : R_2, and the angle M Q N has for its tangent, $\frac{C_1 \pi R_1 R_2}{T R_1 + R_2}$,

and $NM = QM \cdot \tan MQN$,

therefore $NM = QM \cdot \frac{C_1 \pi R_1 R_2}{T R_1 + R_2}$.

Hence $\frac{NM}{R_2} = C_1 \pi \cdot \frac{R_1}{T R_1 + R_2} \cdot QM \cdot = \frac{C_1 \pi}{T} \cdot QE$,

and N M is at right angles to Q E;

therefore $\frac{NM}{R_2}$ is the charging current of the condenser C_1, or N M is the E.M.F. which, acting through the resistance R_2, would produce the charging current for that condenser; and N M = O F. Hence $\frac{OF}{R_2}$ is the charging current. But $\frac{EC}{R_1}$ is the current in R_1 discharging the condenser in that section, and $\frac{EC}{R_1} = \frac{FE}{R_2}$.

Hence $\frac{EF}{R_2}$ is that current considered as one of the two components of the charging current $\frac{OF}{R_2}$.

Therefore $\frac{OE}{R_2}$ is the other component, *i.e.*, O E is the effective E.M.F. in the section R_2.

But this section has a coefficient of self-induction L_2, and $\tan OEP = \frac{L_2 \pi}{T R_2}$.

Therefore P E is the impressed E.M.F. necessary to produce the effective E.M.F. O E in this section.

But the impressed E.M.F. in R_2 is the resultant of the two E.M.F.'s of the condensers C_2 and C_1, and E Q is the E.M.F. of the condenser C_1.

Therefore, finally, P Q is the E.M.F. of the condenser C_2, or, if there be but one condenser, C_1, P Q is the E.M.F. of the generator.

The extension of the diagram to give the E.M.F.'s involved in the next section, R_3, will be easily understood if the steps are merely indicated, as follows:—

$$QM' : QP :: R_3 + R_2 : R_2,$$

$$\tan M'QN' = \frac{C_2 \pi R_2 R_3}{T R_2 + R_3}, \quad QM'N' = \frac{\pi}{2},$$

$$OF' : EO :: R_3 : R_2,$$

F' O' is equal and parallel to M' N',

O' K is equal and parallel to O P,

$$\tan KPP' = \frac{L_3 \pi}{T R_3}, \qquad PKP' = \frac{\pi}{2}.$$

Then P' Q is the E.M.F. of the condenser C_3, or, if there be but two condensers, of the generator, and K P is the effective E.M.F. in R_3, *i.e.*, $\frac{KP}{R_3}$ is the current in the section R_3.

Again, from the two lines P' Q, K P, with a further knowledge merely of the resistance and coefficient of self-induction of the next section R_4, we can deduce the current in that section and the E.M.F. of the generator or condenser C_4, as the case may be. Thus a complete diagram may be made showing the phases and magnitudes of every E.M.F. involved.

On contemplating Fig. 11, there is one important point to be noticed, viz., that self-induction in the sections by no means

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necessarily diminishes the currents in them, but up to a certain point may be actually beneficial. This cannot be the case when there is no capacity in circuit. Under such circumstances the self-induction must invariably diminish the current produced by a fixed electromotive force, but when condensers exist, it may happen that a smaller E.M.F. in the generator will produce a given heating effect in the sections of the circuit, by virtue of the self-induction in the sections, than would have been required had there been no self-induction.

In the diagram, Q O would have been the position of the line representing the E.M.F. of the condenser C_2 had there been no self-induction in the section R_2. As there is a coefficient of self-induction L_2 attaching to this section, the line of E.M.F. of the condenser C_2 takes the position Q P. Now O P is merely drawn at right angles to O E, and such that $OP = OE \frac{L_2 \pi}{T R_2}$. It is clear, therefore, that when the angle Q E O is less than 180°, a certain amount of self-induction will make Q P smaller. This will be the case until Q P O is a right angle, after which an increase in the coefficient of self-induction will necessitate a larger impressed E.M.F. to produce the given effect.

Similarly if Q P K is less than 180°, Q P′ may be diminished by increasing L_3 up to the point when Q P′ K is a right angle.

When Q P′ is at a minimum, and therefore at right angles to K P′, it is parallel to P K. In other words the phase of the impressed E.M.F. coincides with that of the current in the generating section. And similarly, for every section the E.M.F. of the condenser C_m would be a minimum when its phase corresponds to that of the current in R_m, a condition settled by the proper finite value being given to L_m.

An important case is that in which a generator operates in a circuit which is only closed by a condenser. If the condenser is a leaky one, the resistance through the leak is that represented by R_1, the remainder of the circuit is represented by R_2, for which there is a coefficient of self-induction L_2. Here L_1 is zero, and therefore in Fig. 11 the angle Q E C will be zero, or Q will coincide with C, F with M, and O with N, and the diagram is reduced to Fig. 12.

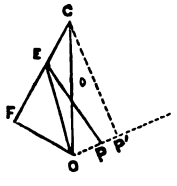

Fig. 12.

When there is no self-induction, the impressed E.M.F. for given effective E.M.F.'s in the two circuits is C O; but as L_2 increases from zero the impressed E.M.F. necessary becomes smaller, as C P, where $\tan P E O = \frac{L_2 \pi}{T R_2}$. This goes on until P arrives at P′, when the angle C P′ O is a right angle, at which point the impressed E.M.F. is a minimum. The condition that this shall be the case is easily deduced from the geometry of the figure, and is expressed by the equation

$$\frac{T^2}{\pi^2 C}\left\{\frac{1}{L_2}-\frac{1}{C R_1^2}\right\}=1 \quad . \quad . \quad . \quad . \quad . \quad (\alpha)$$

which shows it to be independent of R_2, or the resistance in the section including the generator. From the above the proper value for L_2 may be deduced. It may, however, be observed, that as long as L_2 approached the value indicated by this equation, all practical advantage will be gained, because, C P′ O being a right angle, a variation in the value of the angle O E P′ will only affect the length of C P′ infinitesimally.

The proportion in which the presence of the beneficial coefficient of self-induction renders it possible to reduce the impressed E.M.F. is the relation which C P′ bears to C O. This relation is expressed by the fraction

$$\frac{R_1 \sin^2 \alpha + R_2}{\sqrt{(R_1+R_2)^2 \sin^2 \alpha + R_2^2 \cos^2 \alpha}},$$

where α is the angle O C E, *i.e.*, is the angle whose tangent is equal to $\frac{C \pi R_1 R_2}{T R_1 + R_2}$.

The case is still simpler where the condenser is not a leaky one. In this case R_1 is infinite, and in Fig. 12 the point E coincides with F, and the line O E is coincident with the line O F, so that O P, which has to be at right angles to O E, becomes parallel to C F, the circumstances being simply represented by Fig. 13.

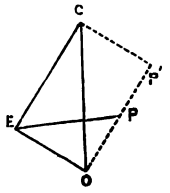

Fig. 13.

From this figure it is evident that when the self-induction coefficient is of the proper magnitude to allow the impressed E.M.F. to be a minimum, as represented by C P′, then this E.M.F. will also be the value of the effective E.M.F. in the circuit, represented by O E.

The tangent of O C E is $\frac{C \pi R_2}{T}$, which is the value of $\frac{C \pi R_1 R_2}{T \,.\, R_1 + R_2}$, when R_1 is made infinite, and the tangent of P E O is $\frac{L \pi}{T R_2}$.

But when P moves to P′ these angles become complementary to each other; that is, the tangent of one of them is equal to the inverse of the tangent of the other.

Hence this condition is expressed by the equation

$$\frac{C \pi R_2}{T} = \frac{T R_2}{L \pi},$$

whence $T = \pi \sqrt{C L}$ . . . . . (β)

R_2 disappearing from the equation.

This condition can also be deduced at once from the equation (α) by putting R_1 = infinity.

The result may be summed up in the following words:—When an alternating generator operates upon a circuit which is closed by a condenser without leakage, and which possesses a coefficient of self-induction, then there is a certain period of alternation which may be given to the generator, at which the condenser might be replaced by a junction introducing no additional resistance into the circuit, the coefficient of self-induction being also removed, without disturbing the current. The condenser, in fact, in conjunction with the coefficient of self-induction, will obliterate the effects of the breach of continuity in the conductivity caused by the infinite resistance of the condenser itself. Moreover, this state of things is quite independent of the resistance of the circuit itself, which will then simply regulate the current in the same manner as with continuous uniform electromotive force.

It is to be observed that the advantage gained by establishing the critical relationship between the capacity, the coefficient of self-induction, the period, and the resistance in the remote section, when that is finite, is simply one of diminished potential. It is not one giving greater direct economy, because the power at work will be the same whether that relationship is established or not, since (Fig. 12) the power is equal to $\frac{O E}{2 R_2} \times P C$ multiplied by the cosine of the angle between E O and P C, *i.e.*, the power is equal to $\frac{O E, P' C}{2 R_2}$, even if P does not coincide with P′, and a similar remark may be made in other cases.

(TO BE CONTINUED.)

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EXPERIMENT WITH A SHUNT-WOUND DYNAMO USED AS A MOTOR.

BY GISBERT KAPP.

Some time ago the author had occasion to use a shunt-wound dynamo as receiver in transmitting power electrically, and in doing so he observed a phenomenon which was not only very puzzling, but threatened to make the transmission of power impossible, unless the cause could be discovered and remedied. As similar difficulties might arise in other cases, an account of those experiments will probably be useful to some of the readers of this journal. It is well known that a series-wound dynamo when used as a motor runs in the opposite direction to that in which it has to be driven when used for the generation of a current. To make the machine run in the same direction (call it forward) the coupling up between the brushes and the field coils must be reversed. With a shunt machine this is not required; generally speaking it can be used as a dynamo, or as a motor, without any alteration in the coupling up between the armature and the field. The shunt machine used in the experiments was driven by a current generated by a compound dynamo, the shunt of which was weak as compared to the main coils, and when doing little or no external work it behaved in a most erratic manner, running backward and forward alternately. At every reversal excessive sparking took place at the brushes of both the motor and generator, and it was clear that both machines were overstrained, and would speedily come to grief if the current were left on.

To explain what takes place under these conditions we will start with the assumption that the generator is kept running, and that the motor is switched on whenever power is required. This is the usual practice where motive power is used at intervals for industrial purposes. Since the generator is a compound machine the leads remain charged to the full working potential during the time the motor is not in use, and immediately on switching it on the current is provided with two paths by which it can flow from the positive to the negative lead. The one is through the armature of the motor, and the other through its field coils. As the motor is at rest, there is no counter electromotive force to oppose the flow of current through the armature, and the result is a momentary excess of current. The immediate effect is that the armature is started revolving at a high speed before the field magnets have had time to get excited, for it must be remembered that an armature will revolve in a non-excited field, though with considerable waste of current. The speed required to produce a given counter-electromotive force is the greater the weaker the excitation of the field, and hence the motor starts running at a much higher speed than it would have in regular work. On account of self-induction in the field-magnets, which in a shunt machine is considerable, the magnets require some time to become fully excited, and whilst the strength of the field is growing the armature is gathering speed and storing up mechanical energy. When at last the field magnets are saturated, the speed of the armature is so great that the counter-electromotive force in the motor not only equals but exceeds the potential maintained in the leads by the generating dynamo, and the current is forced back into it. For the time being the motor is transformed into a generator, the energy stored mechanically in the revolving armature of the motor being returned to the circuit in the shape of current. This reverses the polarity of the compound machine (the shunt coils being weak as stated above), and now both the generator and the armature of the motor are working in series, the generator assisting instead of opposing the current started by the motor. At this moment we have the following state of things:—The field magnets of the motor have just attained their maximum of saturation with their original polarity; the polarity of the generator has been reversed, and an excessive current, in an opposite direction to that which produced motion, flows through the armature of the motor. Consequently the armature is quickly brought to rest, and started in the opposite sense (backward) at a high speed. It now opposes a certain counter-electromotive force to the current from the generator, but it is not an increasing force as before, but a decreasing one, because the orignal excitation and polarity of the motor field magnets is gradually vanishing, by reason of the reversal of polarity in the main leads, from which these shunt coils are fed. Just as it took a certain appreciable time (several seconds) for the magnets to become excited, so does it take time for them to lose their magnetism. Eventually there arrives a moment when all the original polarity in these magnets has vanished, and when, therefore, the force impelling the armature to run backward has also ceased, though there is still an excessive current passing through it. A moment later the armature comes to rest, and begins to run forward at a high rate of acceleration, when the whole cycle of phenomena just described is gone through again, but this time starting with a current in reverse direction to the first. The next (third) cycle will start with a current in the same direction as the first, the fourth cycle with a reverse current, and so on until the belt is thrown off the generator, or some other mishap takes place. If the generator is a compound machine, deriving most of its exciting power from the shunt coils, it may be that the mechanical inertia stored in the armature of the motor is not sufficient to reverse the polarity of the generator, and then no difficulty arises; but with a series machine for a generator, or with a compound machine deriving most of its exciting power from the series coils, the phenomena just described are sure to take place, unless some special precautions are taken. The difficulty can be met by keeping the shunt coils of the motor field magnets permanently connected with the main leads, and interrupting only that part of the current which goes through the armature. The switch should also be joined with a rheostat, so as to prevent any excess of current whilst the motor is yet at rest. After the latter has attained its normal speed the resistance of the rheostat may be cut out either automatically by a centrifugal governor or by hand.

But with all these precautions there is still some danger of reversal if the speed of the generator should temporarily slacken, and the best and safest plan is to use the same type of machine for the generator and motor. The experiments just described afford an interesting example of the relation and interaction between self-induction or electro-magnetic inertia and the purely mechanical inertia as represented by the energy stored up in a heavy revolving body.

LOSS OF THE TELEGRAPH STEAMSHIP "MAGNETA."

Since the loss of the "La Plata" the telegraph world has not had to deplore a catastrophe such as that which has now to be recorded, for it is useless to imagine that we can any longer have hopes of the safety of the missing steamer the "Magneta." During the week reports received from the captain of the "Palmyra" have stated that one of the boats belonging to the "Magneta" was seen 200 miles off Finisterre, and that there was no evidence of the boat having been occupied. The oars did not appear to have been used; a part of the mast was lying across the gunwale, and about 18 inches of top plank knocked in; otherwise the boat seemed to be in good condition, and appeared to have been properly lowered. There seems to be no doubt that the unfortunate vessel went down with all hands. The disaster may have arisen from one of several causes. It may have been directly due to the results of a storm. There is one point, however, generally overlooked in the loss of steamers. We do not wish to hint in the slightest possible manner that such an accident occurred in this case; but with every precaution taken machinery does sometimes go wrong, and no doubt many missing ships have been sent to the bottom through the bursting of their boilers. An accident of this kind, more especially if occurring in the midst of a storm, would almost necessarily be fatal. A full description of the ship appeared in our issue of 3rd January, from which it will be seen that the details of the construction had all been carefully considered, and, so far as can be seen, no effort had been spared to make the vessel thoroughly seaworthy and efficient in every respect. It is not, however, the loss of the vessel we so much deplore as the

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loss of its crew, including as we do in this one general term the whole of the fifty-four souls on board. It will not be possible for us to refer to all of these, but we may mention the names of a few who seemed destined in the heyday of their youth to do good work in the service of the cable companies; their loss is felt, and their experience cannot be replaced.

THE LATE CAPTAIN MERRALL.

Captain Merrall was for some years in the service of the Telegraph Construction Company, and joined the Eastern Telegraph steamer "Chiltern" as second officer in 1880. In 1882—recommended by Sir James Anderson—he was appointed by the Eastern Extension Company first officer on board their repairing ship "Sherard Osborn." In September last Captain Merrall returned to England on leave of absence, and in January of the present year was instructed to proceed to Glasgow, and was appointed to the command of the "Magneta," then building on the Clyde. The vessel left the Clyde under his command on the 6th, and arrived in the Thames, after a somewhat stormy passage, on the 9th of February. The test of the ship during this passage was sufficient, in the opinion of the captain, to prove its suitability for the work before it. Captain Merrall had scarcely reached the prime of life, and during the five years he has been connected with the Eastern and Eastern Extension Companies gained the goodwill of all with whom he was brought in contact. By his untimely death the companies have lost a valuable officer and a skilled navigator.

THE LATE MR. J. M. MILLER.

Mr. James Miller, the chief electrician on board the "Magneta," joined the Eastern Extension Company in August, 1877, as telegraphist. In April, 1878, he was promoted to be assistant electrician, and in 1880 was given charge of the electrical department on board the company's hulk, "Southern Ocean." In July, 1883, he was appointed electrician on board the ss. "Agnes." In April of last year Mr. Miller left Singapore for England on leave of absence, and during his stay in this country he rendered great service to the company in suggesting and superintending the fitting up of the electrical department of the "Magneta." We had the pleasure of seeing him several times just before the commencement of his ill-fated voyage, and he spoke in glowing terms of doing good service with the vessel. Young and enthusiastic, and an exceptionally good electrician, the company and his friends have experienced a loss which will be long remembered.

THE LATE MR. T. E. WATSON.

Mr. T. E. Watson, chief engineer, joined the Eastern Extension Company in July, 1881, having only a few months previously had a narrow escape from drowning through the wreck of the "Braemar Castle," off Penang. He has held the appointment of chief engineer on board the ss. "Agnes" since the above date. Mr. Watson left the East last summer for England. In January of the present year he was appointed chief engineer on board the "Magneta." Mr. Watson was a very trustworthy officer, and as an engineer possessed great ability.

THE LATE MR. HENRY SEAWARD.

Mr. Seaward was returning to the East on board this unfortunate vessel, having been in the service of the Eastern Extension Company since 1870. For some few years Mr. Seaward was junior clerk at Madras, and in 1878 was appointed to a first class clerkship at Batavia; four years later he was transferred to Cape St. James as acting superintendent, which appointment was confirmed in 1883. Mr. Seaward was a very active man, and although firm he was kind to those under him, and made many friends who will be grieved to hear of his loss.

THE LATE MR. E. C. COX-SMITH.

Mr. Cox-Smith was a junior officer in the Company's Saigon Station, and joined the Eastern Extension Company's service in June, 1880. He came home on leave in August last, and was on his way back to his station. As an operator he possessed great ability, and was interested in the higher branches of electrical science. He was a great favourite among the staff in the East.

THE LATE MR. J. S. SHAPLEY.

This gentleman was for some years in the service of the Eastern Company, and joined the Eastern Extension Company in October, 1875, when he was appointed to the charge of the Nelson Station, where he has ably officiated in the capacity of superintendent since that date. Mr. Shapley was well known in the Australasian colonies, where he had made a large circle of friends.

Besides the gentlemen already mentioned, there were on board two young friends of Sir James Anderson, Messrs. Toynbee, who were going out to join their brother in an undertaking in the Straits. Mr. W. H. Webster, a personal friend of Mr. Lynes, the assistant-secretary of the Eastern Extension Company, was going to Malta, for the benefit of his health. This gentleman was well known and much respected at the Audit Office, Euston, where he has held an appointment since 1866. Messrs. Hughes and Jones, in the engineering department, were proceeding, the former to Perim for the Eastern Company, the latter to Tonquin to superintend the erection of the Company's quarters there.

INCANDESCENT LIGHTING IN AMERICA.

We quote the following from our American namesake:—"The following isolated plants have been recently introduced by the United States Electric Lighting Company, or are now in process of construction:—Washington Building, N.Y., 900 lights; New York Post Office, 1,200 lights; Frank Leslie's, N.Y., 200 lights; Union Ferry Co. (two new boats), 150 lights; Pennsylvania R.R. Station, Jersey City, 600 lights; Smith, Gray, and Co., Brooklyn, 160 lights; Palmer House Barber Shop, Chicago, 300 lights; Royal Insurance Co., Chicago, 1,155 lights; Home Insurance Co., Chicago, 1,500 lights; U.S. Custom House and Post Office at Chicago, 750 lights; ditto Cincinnati, 800 lights; ditto St. Louis, 750 lights; U.S. steel cruiser, 'Atalanta,' 200 lights; Las Vegas Hot Springs Co., Hotel, New Mexico, 652 lights; Geo. H. Friend and Son, W. Carrollton, Ohio, 60 lights; College of Ottawa, Ottawa, Ont., 100 lights; New York and Phila. and N.R.R. Co., steamer 'Cape Charles,' 75 lights; Middlings Purifier Co., Jackson, Miss., 250 lights; Nashville Cotton Co., Nashville, Tenn., 250 lights; P. Espinal, Theatre, Caracas, Venezuela, 500 lights; Battle House, Mobile, Ala., 200 lights; Fred. Hauson, Hotel au Claire, Wisconsin, 100 lights; Samuel Cupples's Factory, St. Louis, Mo., 150 lamps; Huron Mills, Ypsilanti, Mich., 150 lights; U. S. Post Office, Philadelphia, Penn., 600 lights; E. W. Hydorn and Son, Troy, N. Y., 690 lights; A. S. Turner, Elmira, N. Y., 575 lights; Mortimer Building, New York, 100 lights; Hamilton Club, Brooklyn, 300 lights; Mutual Life Assurance Co., new building, New York, 750 lights. This last plant has been substituted for a large installation of Sawyer and Mann lamps, which has been in operation for lighting the building for some time past, but has been rejected as unsatisfactory, and the Weston incandescent system substituted for it. A new stock company is to be formed in Chicago for the manufacture of a new system for operating incandescent electric lights, invented by Harold P. Brown, electrical engineer. Electric light companies have been formed in Columbia and Lancaster, Penn."

A NOVEL APPLICATION OF ELECTRICITY.—In the *Elektrotechnischer Anzeiger*, of Berlin, there is a description of a somewhat novel installation in one of the cafés in that city. Electricity not only lights and ventilates the building, but *prepares the coffee*. In the centre of the establishment is placed a buffet carrying a small electric motor which works a coffee mill. The water is heated in a large glass bottle in which is placed a spiral of platinum wire traversed by the current; a quarter of an hour suffices to heat the water to boiling point. There are no waiters to serve the customers; each table is in communication with the central buffet, and by means of a small electric railway, the articles required for consumption are transported to the visitors.

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THE ELECTRICIAN.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

WAR AND SUBMARINE CABLES.

In our last issue we drew attention to the unsatisfactory condition of our lines of telegraphic communication with the East; and we are glad to observe that the matter has been promptly brought to the notice of the Government through Parliament. Not that we can suppose that this is the first time they have given any consideration to the subject; on the contrary, their advertisement for tenders relating to certain West African cables some months ago shows that Ministers were beginning to realise the true situation of affairs. But there still appears to be great lack of knowledge as well as great diversity of opinion among heads of Departments as to what steps should be taken to remedy the defects of the existing system, and even as to the utility of any steps whatever that could be taken.

This was singularly manifest in the short discussion which arose on Viscount Sidmouth's question in the House of Lords on Tuesday evening. Our note of warning last week had direct reference to the possibilities of a war with Russia, and the difficulty of maintaining telegraphic communication with India, independently of foreign Administrations, should hostilities unfortunately break out. For reasons quite intelligible at the present juncture Viscount Sidmouth confined his inquiry to the case of China, asking whether any attention had been given to the fact that our sole route of telegraphic communication with Hong Kong and other British settlements—including, no doubt, certain important coaling stations—in the East was by wires passing through territory belonging to foreign Powers. Lord Derby in his reply ignored the facts alluded to in our note as touching the routes taken by the wires nearer home; but was constrained to admit that at their distant ends they had to pass either through Russian and Chinese territory, or through the French settlement at Saigon. With the usual official optimism his lordship deemed it of great advantage that these two routes were available, because if we were at war with one Power there would still remain the route belonging to the other. The contingency of a war with both Powers at the same time, or with one Power who had a very good neutral friend in the other, does not seem to have occurred to the Colonial Secretary. We sincerely hope he may not be rudely undeceived. Of course the question of cost came in. The maintenance of an independent line from Singapore to Hong Kong would involve an expenditure of £20,000 a year. We think there is some mistake here; but as another noble lord, the head of the Naval Department, virtually admitted that considerations of cost ought not to outweigh political considerations, nothing more need be said on that point.

But Lord Derby added as a final reason for doing nothing a fact alluded to in our last week's note—namely, that to secure complete independence of communication we must have fresh lines to Gibraltar and Malta. Now, as to this, although a point of some importance, it is not to be compared with the facts of our dependency largely upon wires passing through Russian and French territory. The present submarine lines to Gibraltar and Malta touch at Vigo and Lisbon; places which, we need hardly say, are on territory far less likely to be involved in hostilities than the countries we have named. Besides, as we pointed out at the time, these cables could, in case of need, be detached, so to speak, and spliced through to their British destination. We were right in saying that our position in respect to direct communication was not generally understood. An ex-Colonial Secretary, joining in the discussion, questioned the accuracy of Lord Derby's concluding statement that we had no direct cable communication with Gibraltar, alleging that he—Earl Carnarvon—had actually seen it at work. What he had seen, no doubt, was the direct transmission of messages between London and Gibraltar or Malta, from which he has apparently inferred that the cable went straight to its terminus. It might surprise him to be told—which is quite possibly the fact—that what he saw was the transmission of messages across France by way of Marseilles; and France is at all events a possible foe in the event of a European war.

But, by whatever way Earl Carnarvon's "direct" communications travelled, it is certain that under existing arrangements a large portion of the telegraphic traffic to the East goes by way of France; and there consequently arises the very important question of Lord Salisbury, as to whether a neutral nation can maintain its neutrality and yet transmit war messages for one of the belligerents. That such a question has been raised—as we understand Lord Salisbury to say it has—and still remains to be settled, is a startling announcement. On the face of it the same principle ought to apply to Telegraphs as to Mails; but, as was pointed out, if the neutrality of the country over which war telegrams travelled were not of a very benevolent kind—in other words, was rather hostile than friendly—the importance of independent submarine cable communication becomes very great indeed.

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Earl Carnarvon's suggestion that requisite stores and appliances should be accumulated at suitable places ready to repair, to supplement, or to divert the routes of cables injured by the enemy, or touching unfriendly soil, is deserving of immediate attention. Hitherto the Government have relied almost solely upon the commercial instincts of the nation to supply communication and keep it unimpaired. They have also received much help from the patriotism of owners of cables, who have gone outside their commercial province in order to give the Government a helping hand. But it is time the Government helped themselves. They might have had more than one absolutely independent cable route to the East if they had chosen to recognise frankly the fact that the telegraph is an imperial as well as a commercial necessity. They have allowed the lines to take a purely commercial track, without providing for their instant conversion into political routes; and they have offered no pecuniary inducements—with only one exception recently, we believe—for the construction or extension of lines where commerce alone would not attract them. As to initiating a line on political or military considerations exclusively, it seems never to be thought of; at all events, England will be agreeably surprised if, when the next war breaks out, it is found that ample provision—or, indeed, any provision at all—has been made to enable this country to assume exclusive control over her communications with those distant dependencies which she is bound to protect, and on whose safety the success of her own naval and military operations so much depends. There are two or three obvious measures required to render us more secure in these and similar respects—measures which we hope may be adopted at once, but which on the eve of a great war we need not specify more precisely.

CORRESPONDENCE.

DOMESTIC ELECTRIC LIGHTING.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of April 11th appears a letter advocating the use of Balmain's luminous paint in the construction of commutators for household fittings. The writer of that letter is in error in supposing that such an application of the paint has not occurred to constructors. We should imagine that many will have used it. We put rings of luminous paint round the commutators in our very first incandescent installation, and we have used it freely for commutators, electric-bell pushes, and indicators, &c.

Electric light commutators should always where possible be put near the door, as the light of the paint does not prevent people stumbling over things on their way across a room. So fitted they answer their purpose admirably.—Yours, &c.,

ANDERSON AND MUNRO.

136, Bothwell-street, Glasgow, 11th April, 1885.

NEW ORLEANS EXHIBITION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with much interest Mr. Verity's description of the Edison exhibit at New Orleans in your last issue.

I also have recently returned from the United States, where I was on electric lighting business, and I must say that one thing struck me quite differently from Mr. Verity—viz., the extension of the incandescent system to the detriment of the arc. I quite agree with him that such installations as the New York Down Town Station are unknown here, and the use of the incandescent lamp is no doubt increasing enormously; but I hardly think it is replacing the arc. I am interested in electric lighting generally, and, as my connection with the Edison-Swan system proves, extremely so in the incandescent system, though the arc, also, most certainly has its place. For interior or domestic illumination the glow lamp reigns supreme, and the arc is inadmissible; but for large open spaces, high workshops, stations, streets, squares, docks, &c., the arc must prevail; and this is fully appreciated in America, as may be shown when I mention that the arc system (the Thomson-Houston), which my firm are now introducing into this country, has put up since its commencement, little more than a year ago, over 9,000 lamps, and the daily out-turn at the factory is a hundred light plant complete.

The appearance of the streets of the American cities certainly would, without other proof, show that the arc system was not yet doomed, for they are a regular blaze of light. At one corner in New York I counted 78 arcs that I could see without moving. By walking a few steps to get different views down the four streets at the corner I could see 20 to 30 more. This appears almost incredible to English ideas; but I hope we may see the day [night? ED.], and that very soon, when our streets may be properly lighted by arcs, the value of this light being fully appreciated by our cousins, whose dictum is that "every arc replaces a policeman."—Yours, &c.,

C. J. WHARTON.

8 and 9, Holborn-viaduct, April 13th, 1885.

INCANDESCENT LAMPS AND THEIR HOLDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of March 14th appeared a letter from Mr. Sydney Walker, headed as above, and illustrating, as new, a form of holder that has been very familiar to me for the past two years. Having no reference handy, I cannot give exact dates, but possibly Messrs. Woodhouse and Rawson can supply the omission, as whilst in their service I designed a holder similar in every respect, and which I have always understood was patented at the same time as their other three-pronged form.

Of course, in mentioning the matter I do not wish to convey any imputation against Mr. Walker—far from it; but possibly early notice of the matter may prevent future unpleasantness, and as Mr. Walker admits that until *very recently* they could find no better form than the old Swan spiral, doubtless my priority will be readily acknowledged, though both parties may be *bonâ fide* inventors of the same article.

In conclusion, allow me to endorse Mr. Walker's good opinion of the holder.—Yours, &c., C. SCOTT SNELL.

Culver Park, Saltash.

ANIMAL ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The smart, racy letter of "A. S. T. E." in your issue of 21st February fits in most admirably with the letters from W. A. Rudge, which appear also on the same day and in a previous issue of your very useful paper.

I have no doubt that every electrician has observed in a greater or lesser degree all the phenomena your correspondents describe, but a very natural feeling of uncertainty, when we are all groping so very much in the dark, causes one to hesitate before committing to publicity, as absolute facts, the thousand and one apparently remarkable things that the practical electrician is daily stumbling across whilst pursuing even the ordinary routine of his profession, and it is to be regretted that the time requisite for following them up is invariably denied him.

I quite anticipated, however, seeing a very voluminous correspondence to you on the subject, considering its really great importance, and I am at a loss to understand how it is that so very few amongst the readers of so valuable a paper as *The Electrician* has now become take little more than a passing interest in any other than those facts appertaining to the old and universally-accepted beaten track of electrical science, when it is considered that, advanced as it is, we are practically as ignorant of the true origin and nature of what electricity is as were the earliest pioneers in their primitive explorations of it; and therefore we should leave no stone unturned in following out to the end any ideas which may tend to enlighten our comparative ignorance.

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The question of animal electricity is a very profound one, and anybody who has studied it and experimented upon it must confess that at least the sense of touch and the workings of the mind by thought itself are, of all others, subject and subservient alone to the static electricity which everything in life is endowed with.

If, as a *manière de parler*, we look upon the earth as a general reservoir into which all positive electricity is pumped, so must we consider animal life as the generating. or negative plate, which goes on yielding the same, whether collected from its own source or whether induced from "mother earth," until animation ceases and the "vital spark" has fled for ever.

It is most interesting to watch experiments relating to this force, and I agree to a very great extent with "A. S. T. E." that the rapidity in the circulation of the blood causes an apparent increase in the volume of electricity produced. I look upon it precisely in the light of a "recorder mouse mill" (and to no better electrical machine can animated things be compared), which, if driven very rapidly, will give out, for a time, more power, brightness, cheerfulness, and vitality. But the pace will tell, its speed drops all of a sudden, it stops, it is exhausted, dead; but if driven steadily, and not abused, both the mill and the animal last out that period of time allotted to all things in nature.

My experiments in animal electricity began several years ago, and were frequently made on both bipeds and quadrupeds, giving nearly equal results. The same difference between perfectly healthy individuals and animals that "A.S.T.E." found amongst his sound, debilitated, or phlegmatic subjects, I also found; but what I did notice then, as ever since, was that although my subjects might be perfect, both mentally and physically, the externally nervous, timid man, woman, child, or dog, gave comparatively far lower deflections on my astatic galvanometer than the stolid and immovable-at-any-price natures whose pulses would not beat a trifle higher were a 100-ton gun fired beside them. And I remember commenting on this in 1883, when the fleet under Lord John Hay was here, and when many of the officers were one day visiting my laboratory, each in turn being experimented upon. The difference in the results obtained was remarkable, and as they were all in the best of health I concluded that the difference was entirely due to their nervous condition, and which I verified on questioning them; and I feel confident that that which we call nerve is but the "collecting plate" of the force known as animal electricity, and in proportion to the nerve's strength so is that power retained, to be yielded only when the owner of it *so wills it*, whilst in the nervous man it is as in the defective "mouse-mill," where the electricity cannot be retained, but is ever oozing out, and its power necessarily vitiated. And this is marvellously exemplified in observing the assimilated conduct of a faulty mouse-mill in damp, muggy weather with a man of highly external nervousness. The energy of both is equally absorbed by the damp air, and the result is a profound melancholy in the one and a more melancholy failure in the other.

I was surprised to see that the deflections from "A. S. T. E.'s" subjects were so low. In some cases I have obtained 300 divisions of the scale with a 100 shunt, and that this only gives a faint idea of the actual volume of electricity produced I will endeavour to show, the more so as it is very interesting, and gives one a better idea of what the actual internal resistance of the human cell is. It is well known that in measuring low resistances with a very high resistance galvanometer the multiplying power of the shunts marked $\frac{1}{9}$, $\frac{1}{99}$, and $\frac{1}{999}$ is not that indicated thereby; in fact, it is entirely disproportionate, and the insertion of one or the other of these shunts but very slightly alters the actual deflection of the unshunted galvanometer. But in measuring the animal electricity produced by a human cell I have carefully noted that the multiplying power of the 10, 100, or 1,000 shunts used is nearly if not quite equal in proportion to the deflection of the unshunted galvanometer. Hence it is reasonable to suppose that the internal resistance of the human cell is to be measured, if not in megohms, at least by many thousand ohms—or in other words the intensity of the electricity it could produce, were its internal resistance very low, would be indeed dangerously great.

When these facts are duly taken into consideration, we must confess that the application of electricity for medicinal purposes could be made almost universal, provided that proper attention is paid to the above laws, which alone regulate such applications, and by confining them to Faradic currents only.

Many years ago, I remember applying Faradic currents to cure myself of chronic toothache, to which I had been a martyr for months. I nearly wrenched off my jaw, but I cured it effectually, by killing the nerve, and, although the decay goes on, I have never known toothache from that day to this. Some ten years ago I fell in with a very clever young doctor, who was just developing his electro-therapia in the large hospital of Sta Maria Nuova, in Florence, and although his applications of voltaic currents gave a certain amount of satisfaction, he, at my suggestion, almost entirely discarded them for the Faradic, and really made some remarkable cures. Still, with all this, electro-therapia makes little or no progress.

I have spun this letter out too long to answer friend Rudge, but let him be assured that all his interesting results are very well known, though, alas, he is about the only one who has ever brought them into public notice.

In a further letter I will let him know something more on this interesting and valuable subject.—Yours, &c.,

Zante, April 6, 1885. W. G. FORSTER.

BITUMINOUS COMPOSITION FOR STREET MAINS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Can you or any of your readers inform me what is the exact nature of the bituminous composition employed as an insulating medium in the Edison electric street mains, and also say at what temperature it melts?—Yours, &c.,

S.

April 2nd, 1885.

THE VAN RYSSELBERGHE SYSTEM OF SIMULTANEOUS TELEGRAPHY AND TELEPHONY.

BY M. CHAS. MOURLON.

(CONTINUED FROM PAGE 460.)

II.

As a result of this discovery, M. Van Rysselberghe recommends for the production of the current an element or elements of extremely low internal resistance. In that case

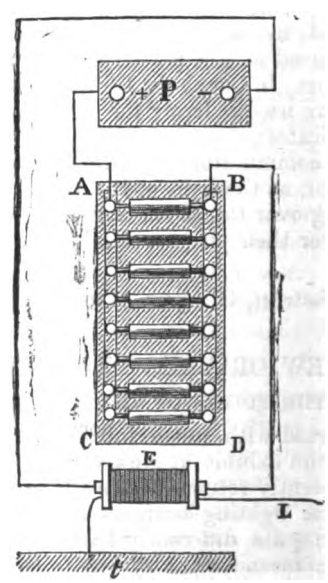

FIG. 3.

secondary cells or accumulators and thermo-electric piles can be employed with advantage. It is not, however, sufficient to diminish the internal resistance of the battery; the resistance of the microphone must also undergo diminution, and in order to effect that purpose he has had recourse to a number of con-

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tacts arranged in multiple arc. This arrangement is shown in Fig. 3.

P, may be either a Planté or a Faure accumulator, or a Leclanché or Warnon cell of large plate surface, and therefore of low internal resistance. A B C D, is a small deal planchette or table, of the same dimensions as that adopted for the Ader microphone. Upon this are disposed, parallel to each other, eight small carbon pencils, connected in multiple arc, and constituting the contacts of the microphone. The total resistance of this instrument does not exceed 2 ohms, whilst that of the greater number of the microphones in ordinary use is about 16 ohms. E, is an induction coil having a primary circuit of small resistance. M. Van Rysselberghe has also minimised the resistance of the secondary circuit, for the reason that long-distance transmission necessitates the use of currents of *quantity*, and not of *tension*. In Fig. 4 the ordinary apparatus designed for service in a telephone office, for long-

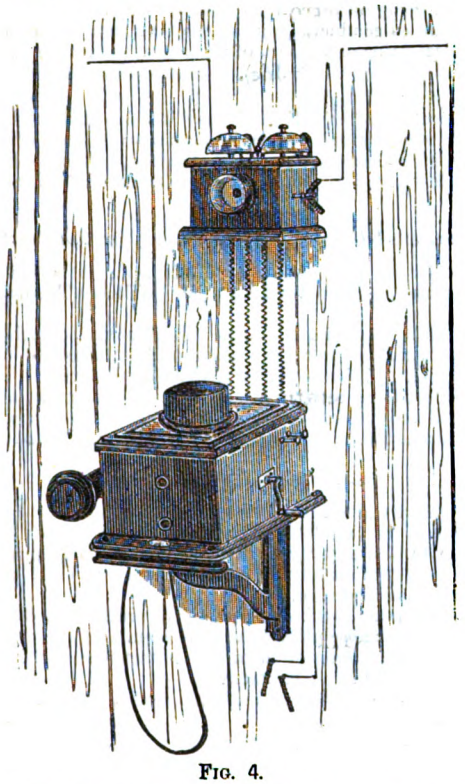

FIG. 4.

distance working, is shown. This apparatus consists of a box of walnut wood containing a complete inductor, which, by means of a small crank placed at the side of the box, actuates the two bells in connection with the two offices. These bells are entirely independent of the transmitting apparatus.

The cover of the before-mentioned box also carries the carbons of the microphone. The small table which supports them is, as we have said, somewhat similar to that of the Ader microphone, but it differs from the latter in that instead of being fixed it is merely packed in a metallic frame. The receiver is a Bell telephone, sheathed in ebonite, the resistance of the coil of which is less than 100 ohms. This receiver rests upon two hooks, one of which is fixed, while the other, which is automatic, acts as a commutator. The installation of the apparatus is very easily effected, and, once placed in position, it does not require to be regulated, nor is it liable to get out of order. An ebonite cylinder is arranged upon the table of the microphone in order to collect the sound vibrations, and direct them perpendicularly upon the diaphragm. This modification is a very simple one, and has given excellent results in regard to distinct articulation.

Fig. 5 is a second model, in which the micro-telephone is mounted upon a desk, so that the messages may be written down as they are received. A paper clip in the form of a hand serves to retain the paper in position. The magneto call is placed beneath the desk, and is put in action by a small crank wheel, which, together with the bell, is of the same description as in Fig. 4. There are six terminals in all, L, communicating with the line, T with the earth, SS, with the two bells, while P P, are connected to the respective poles of a Leclanché battery of the large pattern, placed in a box underneath the apparatus, and resting on the ground.

The last experiments of M. Van Rysselberghe, conducted in the presence of the officials of the Belgian State, sufficiently proved that in order to arrive at perfection it was necessary to make use of very sensitive microphones. The objection has been urged that the expense of replacing the instruments ordinarily used by those of the new system would be considerable, and in order to meet this objection, M. Van Rysselberghe has specially designed some effective and economical improvements to the existing apparatus. The later experiments which have been conducted, *i.e.*, between Ostend and Brussels, 77·5 miles; Antwerp and Brussels, 34·1 miles; Paris and Brussels, 207·7 miles; Oporto and Lisbon, 193·6 miles; Rouen and Le Havre, 57 miles; and, finally, in the Argentine Republic, between Buenos Ayres and Rosario, a distance of 217 miles, have given every satisfaction. The microphones used in these experiments were the same which have been installed in the Theatre de la Monnaie in Brussels, and which enabled Her Majestry the Queen of the Belgians to hear at her Châlet Royal at Ostend, and later at the Laeken Palace, the

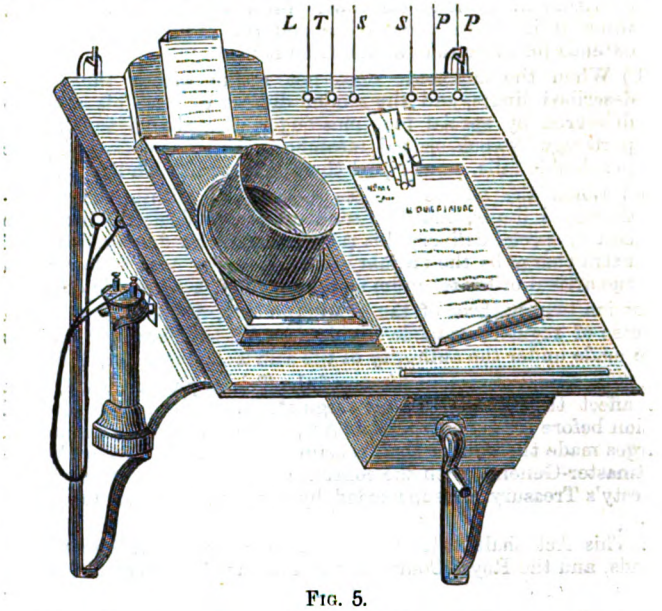

FIG. 5.

music and songs of the opera in Brussels. On the latter occasion the Bell Telephone Company in that city lent its wires from the theatre to one of the offices of the State, which was in actual telegraphic communication with the Palace of Laeken, situated some miles from the town; and, although the music was transmitted distinctly and satisfactorily, no interruption whatever resulted to the telegraphic service then being carried on. As a result of that experiment Her Majesty has ordered a permanent installation to be put down between the Palace and the Opera House in Brussels. The number of microphones necessary for such an installation is fourteen. These are all mounted in multiple arc, and connected to a Faure accumulator of 50 kilos. placed beneath the stage. The accumulator is fed continually by a Bunsen battery, which also serves to actuate the regulators required during the representations in the electric lighting of the stage.

THE NEW TELEGRAPH BILL.

The following is the text of the new Sixpenny Telegraph Bill :—

Be it enacted by the Queen's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same, as follows :—

1. This Act shall be read as one with the Telegraph Acts, 1863 to 1878, and shall be deemed to be a Post Office Act within the meaning of the Post Office (Offences) Act, 1837 ; and this Act may be cited together with the Telegraph Acts, 1863 to 1878, as the

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Telegraph Acts, 1863 to 1885, and may be cited separately as the Telegraph Act, 1885.

2. Section fifteen of the Telegraph Act, 1868, shall be repealed, and in place thereof be it enacted as follows :—

The Postmaster-General, with the consent of the Commissioners of Her Majesty's Treasury, may from time to time make regulations for determining the hours during which the offices appointed by him to be places for the receipt and despatch of telegrams shall be open for the transaction of telegraphic business, and for fixing the sums to be from time to time paid on account of the transmission of telegrams, and on account of services rendered in connexion therewith, and on account of the use of the telegraphs by any persons, and for determining the conditions and purposes on which and for which such use may be permitted, and for the general conduct of telegraphic business : Provided that

(1.) The charges for the transmission of written telegrams throughout the United Kingdom shall uniformly and without regard to distance be at a rate not exceeding *sixpence* for the first twelve words of each telegram or for each telegram of less than twelve words (counting as part of such twelve words the names and addresses of the sender and addressee of the telegram), and not exceeding *one penny* for each additional two words or part of two words :

(2.) The sums charged for the transmission of written telegrams shall be held to cover the costs of delivery by special foot messenger, within the limit of one mile of the terminal telegraphic office, or within the limit of the town postal delivery of that office, when it is a head post office and the town postal delivery extends for more than a mile from it :

(3.) When the addressee does not reside within the above-described limits, and the sender desires to have his telegram delivered by special foot messenger, the charge to him for porterage by such special messenger shall not exceed *sixpence* per double mile, or any part thereof, beyond such limits :

(4.) When the addressee does not reside within the above-described limits, and the sender does not desire to incur the cost of special delivery, his telegram shall be delivered free of extra charge by the ordinary postal delivery next following on the arrival of his telegram at the terminal telegraphic office.

Section twenty-three of the Telegraph Act, 1868, shall apply in the case of regulations made under this Act as if such regulations were made under the authority of the said Telegraph Act, 1868.

3. The repeal of section fifteen of the Telegraph Act, 1868, shall not affect the validity of any regulations made under the said section before the passing of this Act, and such regulations and all charges made thereunder shall remain in force until revoked by the Postmaster-General, with the consent of the Commissioners of Her Majesty's Treasury, or superseded by regulations made under this Act.

4. This Act shall extend to the Isle of Man and the Channel Islands, and the Royal Courts of the Channel Islands shall register the same accordingly ; and for all the purposes of this Act the Isle of Man and the Channel Islands shall respectively be deemed to be part of the United Kingdom.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 463.)

12. This is perhaps the most convenient place to introduce the notes or condensed statements which I drew up and distributed at the meeting before the discussion. They were intended to be critically exact (allowing of course for mistakes and possible slips) so as to bear analysis ; and hence it is probably worth while to reproduce them here with notes and comments.

I. *Orthodox Statements believed by the writer to be true in the form here set down.*

A. *Volta.*

i. Two metals in contact ordinarily acquire opposite charges† ; for instance, clean zinc receives a positive charge by contact with copper, of such a magnitude as would be otherwise produced under the same circumstances by an E.M.F. of about ·8 volt.

ii. This apparent contact E.M.F. or "Volta force" is independent of all other *metallic* contacts wheresoever arranged ; hence the metals can be arranged in a numerical series such that the "contact-force" of any two is equal to the difference of the numbers attached to them, whether the contact be direct or through intermediate metals. But whether this series changes when the atmosphere, or medium surrounding the metal, changes, is an open question ; on the one side are experiments of De la Rive, Brown, Schulze-Berge ; on the other side of Pfaff, Pellat, Thomson, Von Zahn.* It certainly changes when the free metallic surfaces are in the slightest degree oxidized or otherwise dirty. And in general this "Volta force" is very dependent on all non-metallic contacts.

iii. In a closed chain of any substances whatever, the resultant E.M.F. is the algebraic sum of the Volta forces measured electrostatically in air for every junction in the chain, neglecting magnetic or impressed E.M.F. [Verified most completely by Ayrton and Perry.]

B. *Thomson.*

iv. The E.M.F. in any closed circuit is equal to the energy conferred on unit electricity as it flows round it.

[Neglect magnetic or impressed E.M.F. in what follows.]

v. At the junction of two metals any energy conferred on, or withdrawn from, the current must be in the form of heat. At the junction of any substance with an electrolyte energy may be conveyed to or from the current at the expense of chemical action as well as of heat.

vi. In a circuit of uniform temperature, if metallic, the sum of the E.M.F.'s is zero by the second law of thermo-dynamics ; if partly electrolytic, the sum of the E.M.F.'s is equal to the sum of the energies of chemical action going on per unit current per second.

vii. In any closed conducting circuit the total intrinsic E.M.F. is equal to the dynamical value of the sum of the chemical actions going on per unit of electricity conveyed ($\Sigma \cdot J\theta\epsilon$), diminished by the energy expended in algebraically generating reversible heat.

viii. The locality of any E.M.F. may be detected, and its amount measured, by observing the reversible heat or other form of energy there produced or absorbed per unit current per second. [This is held by Maxwell but possibly not by Thomson† though its establishment is due to him.]

II. *Statements believed by the writer to be false though orthodox.*

ix. Two metals in air or water or dilute acid, but not in contact, are practically at the same potential.‡ [Sir William Thomson, Clifton, Pellat.]

x. Two metals in contact are at seriously different potentials (*i.e.*, differences of potential greater than such millivolts as are concerned in thermoelectricity). [This is held by nearly everybody.§]

xi. The contact force between a metal and a dielectric, or between a metal and an electrolyte such as water and dilute acid, is small.‖ [Ayrton and Perry, Clifton, Pellat, and probably Sir William Thomson.]

CHAPTER III.—*Theoretical.*

13. Statement of the writer's own views.
14. Example of the calculation of a Volta-effect.
15. Attempt to mentally represent the action of atmosphere on metals at the instant of contact. Mode in which two Volta plates may be regarded as a condenser.
16. Qualifications and doubts respecting the precise calculation of Volta-effects even for absolutely clean pure metals.
17. Calculation of a series of metal-air contact-forces ; *i.e.*, of an absolute Volta series in air or water.
18. Calculation of Volta series in other media, such as chlorine and sulphur.

Additional note.

13. Before proceeding to the statements embodying my own views, it

* Reprinted from the *Phil. Mag.* for April.

† Observe that it is not said that two metals in contact acquire different potentials. Such difference of potential I believe to be only apparent. Compare Figs. 14 and 15.

* I put Von Zahn on that side because he himself considers himself there, and because the great bulk of his experiments lean decidedly that way.

† The only reason which I can think of as likely to have caused Sir William to doubt or deny the validity of this proposition is given and, I hope, refuted at sections 10 and 11.

‡ The truth or falsity of this statement may be held to depend on a question of words, viz., the definition of potential. Sir William at the meeting said he had always defined potential as the work done in bringing a unit charge close up to, but not *into*, the body. This definition explains some apparent inconsistency in one or two of his utterances which I had never quite understood. But seeing that there is no difficulty whatever in giving a charge up to a metal body, but rather the contrary, why not define its potential in the more simple manner which followers of his have unconsciously, and I believe universally, adopted, not knowing that they were thus putting themselves out of harmony with him ? Given his definition, so that the potential of a body means really not its potential but the potential of the medium close to it, statements Nos. ix. and x. are undoubtedly true ; and No. xi. is also true, I suppose, for it then only means that there is not much E.M.F. between the medium close to a metal and that at a little distance.

§ It is much more natural to suppose that the potential of a metallic conductor is uniform, whether it is homogeneous or not. Indeed, it is not only more natural, but it is true, that two parts of a conductor *can* only differ in potential by reason of an E.M.F. located at the junction. Now there usually is an E.M.F. at a junction, but it is only of such a magnitude as is concerned in thermoelectricity. This, indeed, does produce a difference of potential between the metals, but nothing else can. N.B.—Always provided that by "the potential of a metal" is meant that potential, and not the potential of air near it.

‖ The experiments supposed to establish this really prove only that there is very little difference between the air and the water in which a metal is partially immersed. I do not quite know how to understand, on Sir William's plan, the potential of a metal which is half in one medium and half in another.

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will be more interesting if I try to explain in a fuller and more connected manner what they are.*

Let us regard the air as a dielectric bath of oxygen, in which metals are immersed, and picture a piece of zinc surrounded by oxygen molecules which are straining at it, and endeavouring to combine with it. They may indeed partially succeed ; but suppose they do not, we have here a strong potential chemical action or chemical strain which must probably be accompanied by some physical phenomenon. Now, remember that oxygen is an electro-negative element, and without endeavouring to examine too precisely what signification is involved in that statement, it will be not out of accord with orthodox views if we assume that it means that at least any dissociated oxygen atoms are negatively charged, each with the characteristic charge of a free dyad atom. Granting something equivalent to this, without pressing the form of expression too closely, we perceive that the strain of the oxygen towards the zinc will result in what I metaphorically call a slackening up, or attempted compression, of the negative electricity in it, *i.e.*, in a rise of negative potential. We may therefore say that zinc is at a lower potential than the air surrounding it, and that the step of potential in crossing the boundary from zinc to air is closely connected with the chemical affinity between zinc and oxygen. Observe that this step of potential does not obviously nor probably depend on the amount of oxygen present. It is possible that a few million molecules may be as effective as a large number. Note also that the step of potential is by no means caused by actual oxidation ; in so far as the zinc surface is tarnished by oxidation the strain will be diminished and the step of potential become less.

Nothing is said here about the possible effect of the nitrogen, because it is simplest in the first instance to ignore it, though whether experiment will justify this simplicity or not, I do not yet know.

We may go further and assert that if in general the chemical affinity of two substances can be measured by their energies of combination, then the step of potential in the present case may perhaps be calculable from the heat of combustion of zinc.

And one may justify this assertion thus. Let an atom of oxygen combine with an atom of zinc ; it will generate an amount of heat h, and its characteristic charge, q, will be given up to the zinc and will thereby fall down the step of potential, v, which separates the zinc from the air. *Now, if we suppose that the heat* h *is the representative and equivalent of the fall of energy* q v, it follows, of course, that

$$v = \frac{J\,h}{q}.$$

Make the hypothesis and see what comes of it.

14. The oxidation energy of zinc per gramme-equivalent (*i.e.*, 65 grammes of zinc or 16 of oxygen) is, according to the determinations of Julius Thomsen, Andrews, and Favre and Silbermann, 85,430, 84,825, and 83,915 respectively.

The amount of electricity needed to deposit a gramme-equivalent of zinc, or of any dyad element, is, according to the modern determination of Lord Rayleigh†, 19,320 units.

Hence the value of $\frac{h}{q}$, which is a ratio evidently independent of the number of atoms dealt with, lies between $\frac{85400}{19320}$ and $\frac{84000}{19320}$ probably. Let us say it is $\frac{85000}{19320}$ or 4·4.

Now J in absolute measure is 42×10^6 ; so the value of v, which is $\left(\frac{J\,h}{q}\right)$ according to the above hypothesis, comes out $1{\cdot}85+10^8$, that is 1·85 volt.

This then, I say, is the step of potential between zinc and air. (To avoid circumlocution I will henceforward speak as if the above hypothesis were admittedly true, and all I now say stands or falls with it.)

All clean bright zinc is thus about 1·8 volt below the potential of the air near it ; tarnished or oxidised zinc will exhibit less difference ; and it is perhaps possible that perfectly oxidised zinc need show no difference of potential at all between itself and the air. The step of potential by no means therefore depends upon the occurrence of oxidation ; it is the oxidation *tendency* which causes it, but so far as oxidation actually takes place the step diminishes.

Proceed to consider a piece of copper similarly. Oxygen molecules are straining at it also, but with less force. The combustion energy of copper per gramme-equivalent is given by the three authorities already quoted as 37,160, 38,290, and 43,770 respectively. These do not agree well, and it is difficult to know which to take ; but Thomsen's results are, I believe, generally relied on ; so, assuming his, the step of potential between copper and air will be $\frac{\cdot42\times37200}{19320}$ volts, that is about ·8 volt. This then is the amount by which clean bright copper differs from the air. Oxidised copper will differ less. Comparing this value for copper with that just obtained for zinc, we perceive that a piece of zinc and a piece of copper are, when separate, not at the same potential ; they differ by about a volt from each other. If the zinc is oxidised, they differ less : if the copper is oxidised, they differ more.

Now put the zinc and copper into direct metallic contact, and neglect for the present the third of a millivolt of E.M.F. developed at the junction, which acts so as to drive positive electricity from copper to zinc. A rush of electricity must take place from the copper to the zinc to equalise their potential ; it is impossible that they can remain at different potentials when directly united : all parts of a conductor must be at a uniform potential, and the rush has taken place because they were not so when put into contact.

15. Picturing to ourselves the effect as produced by the straining oxygen atoms, we shall perceive that they could not get at either metal when separate : first, because they surrounded it everywhere, and strained equally on all sides ; and second, because, being all charged with negative electricity, they could not move in on all sides at once without, so to speak, compressing the electricity in the body and giving it an absolute charge. But directly the copper touched the zinc the oxygen atoms were cleared away at the point of contact, and the stress of those at the rest of its surface was no longer counterbalanced. Moreover, they *can* now all move nearer to the zinc because a way of escape for electricity is provided into the copper, whose surrounding oxygen atoms will be thus driven back somewhat further from the surface, until the dielectric strain, assisting the chemical strain on the copper surface and opposing it on the zinc surface, prevents further displacement, and equilibrium is again attained. The electricity which escaped from the zinc to the copper was negative electricity (oxygen being essentially an electro-negative element), the negatively charged oxygen atoms have moved a little nearer to the zinc than their normal distance : *i.e.*, the thickness of its layer of negative electricity is reduced, or its surface is positively charged ; the negative layer on the copper has been slightly thickened—its surface is negatively charged.

This is a pictorial way of representing the process, and may be regarded as somewhat fanciful ; it is, however, the way in which the theory originally occurred to me, and it permits more insight into the processes than a mere statement in terms of potential can ; though it may well be that the imagined processes are but distant likenesses of the real ones.

The oxygen atoms have moved nearer to the zinc ; it is now more easily oxidized than before. The copper, on the other hand, is by contact with zinc somewhat protected.

(TO BE CONTINUED.)

* The reason I set them forth at length is because I had no time at the meeting both to open the discussion and also to properly express my own ideas, and Sir William Thomson was kind enough to tell me to write out the paper completely, and to explain the position I took up fully. This, therefore, I have endeavoured to do.

† "4·025 grammes of silver are deposited by an ampere current in an hour" (Montreal Address). This gives the electrochemical equivalent of silver ·01118, and of hydrogen ·00010352.

EXPERIMENTAL RESEARCHES IN MAGNETISM.*

BY PROFESSOR J. A. EWING, B.SC., F.R.S.E., UNIVERSITY COLLEGE, DUNDEE.

The paper describes in detail experiments of which preliminary notices have already been published. The experiments relate to—

(1) The magnetic susceptibility of iron and steel, the form of the magnetisation curve, and the changes of magnetism caused by cyclic changes of magnetising force.

(2) The influence of vibration on magnetic susceptibility and retentiveness.

(3) The influence of permanent strain on magnetic susceptibility and retentiveness.

(4) The energy expended in producing cyclic changes of magnetisation.

(5) The ratio of residual to total induced magnetism.

(6) The changes of induced and residual magnetism caused by changes of stress.

(7) The effects of constant stress on magnetic susceptibility and retentiveness.

(8) The changes of magnetism caused by changes of temperature.

(9) The effect of temperature on magnetic susceptibility.

The experiments were conducted on pieces of metal which gave as near an approach to the condition of uniform magnetisation as is practically attainable. In some cases rings were used in a manner similar to that employed by Stoletow and Rowland, except that in the present case the process of magnetisation was effected in a series of sudden steps, the total magnetisation being found by summing up the inductive effect of the steps. In most cases, however, the author used straight pieces of wire, whose length was 300 or 400 times their diameter. These permitted the use of a direct magnetometric method of observation, and consequently the magnetising force could be applied and removed continuously and slowly, instead of by sudden steps. Preliminary experiments had satisfied the author that wires of this length gave as near an approach to uniform magnetisation as could be practically obtained by using rings.

Curves are given which show the behaviour of iron and steel in various states of temper, when subjected to a first application of magnetising force, and also to subsequent cyclic changes of magnetising force, such as complete or partial removal and re-application, or reversal. The curves are drawn by plotting either $\mathfrak{I}$, the intensity of magnetisation, or $\mathfrak{B}$, the magnetic induction, in relation to $\mathfrak{H}$, the magnetising force. The characteristics of these curves and their relation to the physical state of the piece under examination are pointed out. Curves so drawn invariably exhibit the static lagging action to which the author (in a former paper) gave the name "hysteresis," any cyclic change of $\mathfrak{H}$ giving rise to a more or less nearly closed *loop* in the curve. Attention was previously drawn to these loops by Warburg, who also anticipated the author in pointing out their important physical meaning, namely, that the area of a loop, or $-\int \mathfrak{I}\,d\mathfrak{H}$, is the measure of the energy expended (per unit of volume) in performing the cycle of magnetisation which the loop describes. In the present paper numerous absolute measurements of this energy are given, especially of the energy which is thus dissipated in each reversal of the magnetism of a piece of iron or steel. These show that while the dissipation of energy by reversal of magnetism is very much smaller in soft iron than in hard iron or steel, even in the latter its amount is very trifling, so that the principal part of the heat which is produced in the cores of

* Abstract of paper read before the Royal Society, January 8, 1885.

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electro-magnets must be due chiefly to other causes than this static hysteresis, and is, in fact, due almost wholly to the induction of so-called Foucault currents in the cores. The relation of this hysteresis to Weber's theory of molecular magnets, as extended by Maxwell, is discussed, and the insufficiency of Maxwell's extension noticed.

By vibrating a piece of soft iron during the application and removal of magnetising force, the effects of hysteresis are almost entirely removed, and the iron is then found to possess almost no retentiveness. But when the application and removal of magnetising force are effected without mechanical disturbance, the retentiveness of soft iron is found to be even greater than that of steel. In some cases 93 per cent. of the whole induced magnetism of a piece of annealed iron was found to remain on the complete removal of the magnetising force. It is pointed out that there is no discrepancy between this result and the well-known fact that a *short* iron core of an electro-magnet retains almost no magnetism when the current in the magnet is interrupted. In that case the ends of the magnet itself, after the interruption of the current, exert a sufficient reversed magnetising force to destroy almost entirely the residual magnetism. But when tested under the conditions which give uniform magnetisation and avoid the demagnetising influence of the ends, soft annealed iron is more retentive than even the hardest steel.

Examples are given showing that the influence of permanent set in the curve of magnetisation is so marked as to give a criterion by which a strained piece may be readily distinguished from an annealed piece of metal, and that strain diminishes very greatly the magnetic retentiveness of iron.

Numerical values of the coefficients of permeability (μ) and of susceptibility (κ) are given for a number of samples of iron and steel, and the relation of these coefficients to $\mathfrak{B}$ and $\mathfrak{H}$ is exhibited graphically after the manner of Rowland. The greatest value of μ refers to soft annealed iron while under mechanical vibration, and is about 20,000.

The next part of the paper deals with the effects of stress (consisting of longitudinal pull) on the magnetic susceptibility and retentiveness of iron, and the subject is taken up in two different ways. In one the magnetic effects are observed when a load hanging from the wire under examination is gradually applied, removed, and otherwise varied, the wire being then either kept in a magnetising field of constant value, or freed from all magnetising force. In the other method the load is kept constant, and magnetising force is applied, removed, and otherwise varied. The two methods give results which would be identical were it not for (1) hysteresis in the relation of magnetism to load, in a constant field, and (2) hysteresis in the relation of magnetism to field, under constant load. The relation of magnetism to varying load in a constant field is examined at great length, both in soft annealed wire, and in wire hardened by stretching, and the effects, which are very complex, are exhibited graphically. They also afford an easy criterion by which a stretched piece can be distinguished from an annealed piece, and, both in stretched and annealed metal, they exhibit static hysteresis, which can be more or less completely wiped out by mechanical vibration. The connection of the author's present work with the earlier results of Villari, and the extensive researches of Sir W. Thomson, is pointed out.

Numerous curves are given, showing the relation to $\mathfrak{H}$ to $\mathfrak{B}$ when the process of magnetisation is conducted while the piece under test is maintained in a constant state of stress. These show very clearly the position of what Thomson has called the "Villari critical point," or point at which the sign of the effect of stress on magnetism becomes reversed; and it is shown that this reversal is associated rather with a particular value of magnetisation than with a particular value of magnetising force, the same reversal being found to occur when the magnetism dealt with is wholly residual.

Instances are given of very curious molecular reminiscences of previous loads, which were found to exist even when the previous loading had been performed at a time when the metal was entirely destitute of magnetism, and although the loads whose effects were found to remain were much less than loads previously applied to the same wire, and were consequently unable to produce mechanical change of any ordinary kind. These residual effects of former loads became visible on the next magnetisation of the piece. It is shown that these effects of previous loads can be almost obliterated by subjecting the wire to vibration before beginning to magnetise it.

The ratio of residual to induced magnetism in soft and hardened iron and steel has been examined for various degrees of magnetisation, with the result of showing that the ratio passes a maximum when the magnetisation is moderately strong, and then falls off as the state of so-called saturation is reached. The influence of the presence of stress on this ratio and on residual magnetism generally has also been investigated.

The last part of the paper deals more briefly with the effect of temperature on magnetism, a subject already largely treated by G. Wiedemann and others. The present experiments were specially directed to discover whether there is hysteresis in the relation of magnetism to temperature when the temperature suffers cyclic changes. Careful experiments on both induced and residual magnetism have led the author to conclude that within the range of temperature dealt with by him there is no perceptible hysteresis in the relation of magnetism to temperature. Curves are also given exhibiting the process of magnetising the same piece at different temperatures. These cross each other in the same manner as the corresponding curves for different values of stress, a fact to be anticipated from the earlier discoveries of Baur.

The experiments, which have been of a very extended character, were made during 1881-1883 in the laboratory of the University of Tokio, Japan, with the help of Japanese students, Messrs. Fujisawa, Tanakadate, Tanaka, and Sakai, to whom the author is indebted for much valuable assistance. The results have been, almost without exception, reduced to absolute measure, and are for the most part presented graphically in curves which accompany the paper.

REPORT ON ELECTRIC LIGHTING IN THE CITY.

The following report, by W. H. Preece, F.R.S., will speak for itself:—

To the Streets Committee of the Honourable the Commissioners of Sewers of the City of London.

Gentlemen: On the 20th September, 1883, the Commissioners sanctioned a proposal that I made to make certain experiments to determine by calculation and by experiment the best distribution of glow lamps to light up efficiently our streets and narrow thoroughfares. I had previously pointed out the relative advantages and disadvantages of arc and glow lamps for this purpose. The light of the glow lamp is constant, steady, and uniform. It lends itself to an even and regular illumination of streets. It requires no personal attention, no adjustment, no cleaning. It can be turned on and off in an instant. Though it enables the existing posts used for gas to be utilised, it can be fixed anywhere, and it enables us to carry out practically the theoretical solution of the difficult problem of the proper distribution of light. I have already indicated, in a preliminary report, the character of the experiments that I have been carrying out in the city, and in Wimbledon, and I will now deal with them more fully under the following heads:—1. The measurement of light. 2. The distribution of light. 3. The measurement of electricity. 4. The distribution of electricity. 5. The cost of production. I will also deal with the questions of domestic, central station, and street lighting.

1. The Measurement of Light.—To measure the intensity of a source of light is a very simple matter when we have a darkened room and a reliable photometer; but to measure the light in a street, or in a hall, when it emanates from many sources, when these sources are fixed in many positions, and at various distances, and when it falls at different angles, is a very difficult thing. The present position of photometry as practically applied to electric light illumination is by no means in a satisfactory condition. I felt that to meet the difficulty we must not depend upon any direct comparison between the light emitted by a source to be measured, such as a gas lamp, and any given recognised standard of light, such as a British standard sperm candle; but that we should rather make our standard of comparison an area illuminated to a given intensity, whatever and wherever be the source of light. We do not want to know so much the intensity of the light emitted by a particular lamp as the intensity of illumination of the surface of the book we are reading, or of the paper on which we are writing, or of the walls upon which we hang our pictures, or of the surface of the streets and of the pavements upon which circulates the busy traffic of cities; we want to know in fact the degree of illumination due to the emitted light, not the intensity of the rays of the source of light. Illumination of this character depends as a rule not on one source only, but on many sources of light, distributed in innumerable ways. Hence to obtain reliable information as regards the illumination of our streets, I proposed to measure the illumination of surfaces quite independent of the sources of light by which they are illuminated. It was necessary in the first place to determine some standard of reference by which comparisons could be made, for all systems of measurement are simply numerical comparisons with some unit taken arbitrarily as a standard. We measure distances by reference to the *yard*, weight by reference to the *pound*, time by reference to the *second*. We know the effect on our eyesight when reading in bright daylight, or dull twilight, or moonlight, and in gas light, or the light of oil and that of candles. In a dull lighted room we are often obliged to increase the illumination of the surface of the book we are reading, by lighting an additional candle or bringing the lamp very near the book. A sperm candle burning at the rate of 120 grains per hour is the parliamentary standard of light in England. In France it is the light emitted by a Carcel lamp burning 42 grammes of pure colza oil per hour with a flame 40mm. high. A single British standard candle placed at about a foot distance, or a French standard lamp at a metre from the page to be read, gives a very fair amount of illumination. As the metrical system of measurement is being gradually introduced into this country, and our relations with foreign manufactures and measures are becoming more and more intimate, it was very desirable to establish a standard that would be applicable to both systems and in all countries. I made my standard the amount of illumination given by a British standard candle fixed at 12·7in. distance. This is very easily reproduced, and it is the same illumination as that given by the French standard light when fixed at a metre distance. It is the same illumination as that given by a steady gas flame burning 5 cubic feet per hour in London when fixed at 3·96ft. distance, or by a 20-candle incandescent or glow lamp at 4·75ft. distance, or by a 1,000 candle-power arc lamp at 105·8ft. distance. In terms of this standard the illumination at the foot of our ordinary street gas lamps, when the burner burns perfectly, is 0·1, while that at the foot of an ordinary arc lamp is 1·8. If we were to give such a standard a name such as *lux*, then the light at the base of a gas lamp post is one-tenth of a lux or a *decilux*, while that at the foot of a Brush arc is 1·8 *lucea*. Having thus established a standard for comparison, it was necessary to devise an instrument to measure with, or to determine the arithmetical ratio between the light to be measured and this standard. Our instrument for the purpose must be light and portable, for it had to be moved about the streets. It required to be easily reproducible at any time and place, and to be absolutely uniform. I took my idea from the fairy lamps used at the Savoy Theatre in "Iolanthe." Here we had something portable, adjustable, uniform, and very easily manufactured. One of these lamps was placed inside a small box, the top of which had a screen of white paper on which was a grease spot. I was able, by increasing or diminishing the current of electricity producing the light, to vary the illumination of one side of this grease spot. When it was desired to measure the illumination of any space, such as the surface of a street, this box had simply to be put at the place to be measured, and the current had

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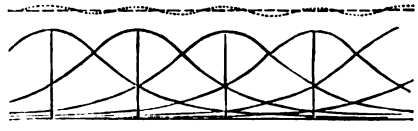
to be regulated until the grease spot disappeared. The current of electricity then became the measure of the illumination, and a simple table gave the result in terms of the new standard. The apparatus proved to be so useful, so novel, and so valuable, and it brought out so new and unexpected a law in the behaviour of the current, that I brought the matter before the Royal Society. Several forms of apparatus had to be made before I obtained one which fully met all practical requirements. Before giving results of these measurements, I must deal with the next point.

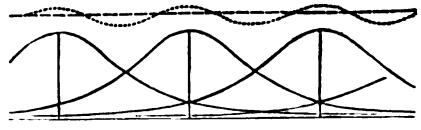
2. The Distribution of Light.—The amount of illumination received by a surface is dependent on the intensity of the source of light, and on the angle of the incident rays. The intensity of the light diminishes as the square of the distance increases, and also as the cosine of the angle which the luminous rays make with the normal to the illuminated surface diminishes. Hence, the practical illumination of our streets is not a very easy question to solve when uniformity and efficiency are desired. We can have either a few intense lights, like the arc electric light, fixed at considerable distances apart, or we can have numerous small lamps distributed about at very short intervals. In the first case we must have either very imperfectly illuminated intervals, or we must have an enormous waste of light; in the second case we can have a fairly uniform distribution of light, if due regard be paid to the laws regulating this distribution. The more intense the light, and the greater the distance apart, the greater the loss and the waste. It was desirable to find out how light was distributed in our street, and then how best it could be done by glow lamps.

The Distribution of Light in our Streets.—The Brush arc lamps are fixed at a height of 15ft. from the level of the pavement, and at a mean distance apart of 150ft. They are nominally 1,000 candle-power lamps, but the mean average intensity of the light they actually emit is by measurement 400 candles. The gas lamps are fixed at a height of 12ft. from the ground, and in the main thoroughfares at a distance of 66ft., measured diagonally across the street. Their nominal candle-power is 14, but their average actual intensity is 10 candles. The Edison glow lamps on the Holborn-viaduct were fixed at the same height and in the same position as the gas. There were some nominal 32 and some nominal 16 candle-power lamps, but their actual mean intensity of light was only three-fourths of this. The simplest method to indicate the way in which these lamps distribute their rays is by a curve, the height of which above the ground-line at any spot indicates the intensity of illumination at that spot. The following curves are the results of actual measurements, and indicate the degree of illumination at different distances from the source of

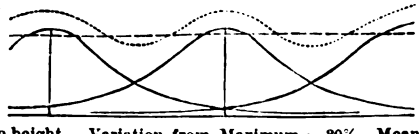
Diagram 1.



Distance apart = the height of the light from the ground. Variation from Maximum = 4%. Mean illumination 1·8 times Maximum of one lamp.



Distance = 1½ times height. Variation from Maximum = 16%. Mean illumination = 1·2 times Maximum of one lamp.



Distance = twice height. Variation from Maximum = 30%. Mean illumination = 0·9 of Maximum of one lamp.

light. The distribution of light on the surface differs of course very materially with the mode in which light is reflected or refracted. Three-fourths of the light emitted by a naked lamp are absolutely wasted as far as the street is concerned; it is lost in the sky. When the intensity of the light is too great for the eyes to bear with comfort, the barbarous practice is in vogue of destroying 50 per cent. of the remaining fourth by covering the light with an opaque, or semi-transparent shade. A good arc lamp should give an intensity of at least 1,000 candles per horse-power, but those in use are often toned down by absorption and obstruction to less than 250 candles. This means wasted energy and a proportionately larger coal or gas bill to pay. The uniform distribution of light over the surface of a street means the utilisation of those rays that are now wasted upwards in the air, and their diffusion without unnecessary loss by absorption. Very rough and unscientific modes of doing this have been attempted by the gas and electric light companies, but with very little success. The light is still distributed in bright patches, which are separated by dark intervals. Gas light must necessarily be enclosed in a lantern which, while it supplies air for combustion, checks draughts and currents which lead to imperfect combustion. It therefore does not lend itself so much to scientific distribution as the electric light, which can be fixed anywhere and anyhow. The question has been most ably and scientifically attacked by Mr. A. P. Trotter, who has produced a dioptric lantern that merits the most careful consideration and examination. It is quite possible, theoretically, to take a light at a given distance from the ground, and so to divert the rays that are now wasted, as to uniformly distribute or spread them over a circular area, whose diameter is many times the height of the lamps. Mr. Trotter has applied to street lamps the same principles that are so effective in our lighthouses in converging all the rays upon a horizontal plane. He makes clear flint glass globes or lanterns of such patterns and shapes that the rays of light are diverted and reflected as shown in Diagram 2.

Diagram 2 shows the influence of this dioptric lantern in spreading the light. The black curve shows the natural diffusion of the unobstructed rays of light; the dotted curve shows the effect of opal globes, or opaque shades; the straight horizontal line shows the effect of the distributing system by means of the dioptric system. The areas embraced by these curves indicate the comparative economy of the different modes. It is seen how wasteful is the obstructive or shaded system. The eye is affected directly by the intensity or quality of the light. It does not take in the quantity of light emitted. The height of the vertical line in these curves gives the intensity at any point, and it indicates how the eye is affected at those points. Thus it shows that, while the dioptric prism apparently lowers the intensity, it spreads the quantity over an enlarged area. Hence it is that when the eye alone estimates the value of the dioptric lantern it is deceived, and it is only scientific measurement by photometers that enables a true conception to be formed of the efficiency of the system. There are other modes of attaining the desired object of distributing usefully the present wasted rays by scattering or reflecting them from white bright surfaces. Many experiments were made at Wimbledon in this direction. The economical distribution of light is largely effected, as I have shown, by its diffusion, but the practical problem as regards our streets is determined more by the amount and degree of light emitted by each lamp, by its height above the ground, and by its position along the street. The illumination of any point is the resultant, or combined effect of all the neighbouring lamps whose rays fall on that point. It is very easy to calculate this resultant when the number of lamps is few, and still simpler to show the result by diagram. Diagram No. 1 shows this distribution when the lights are fixed at various distances apart, and arranged quincuncially, that is, like the five of diamonds, or any other suit of cards. When the distance apart is twice the height of the lamp, there is a variation of 30 per cent., and at three times the height, 60 per cent., but with the dioptric lantern the distribution is practically uniform. It is very easy to show that, from an economical point of view, in an unrestricted space and under ordinary circumstances, it is cheaper to have one bright

Diagram 2.

light, say a 1,000-candle arc lamp, fixed high up in the air, than several smaller lamps, say 20 fifty-candle glow lamps fixed at a lower level; but we are not now dealing with the question of cost, we are considering only the uniform distribution of light, so as to illuminate our streets with the greatest efficiency. The following table is calculated to show the theoretical distribution of light from different sources:—

	Arc lamps 20-ft. post.			Glow lamps, 12-ft. post.	
Candle-power (nominal)	1,000	500	.....	20	50
Horse-power	1	0·75	.....	0·1	0·25
Area illuminated in acres	0·353	0·353	.....	0·1	0·1
Horse-power per acre	2·83	2·12	.....	1	2·5
Length of street, feet	172	172	.....	60	60
Horse-power per 100 feet	0·58	0·435	.....	0·167	0·41
Maximum illumination in luces	2·5	1·25	.....	0·139	0·348
Minimum ditto	0·055	0·0275	.....	0·011	0·0275
Mean ditto	0·41	0·205	.....	0·023	0·0575

As a matter of fact, the mean actual illumination of the arc lamp, owing to obstruction and absorption, is only about one-fourth of the calculated, and the mean actual illumination of the glow lamp by reflection and refraction is twice that calculated. Hence the mean illumination of the 50 candle-power glow lamp and that of the arc may be about the same.

3. The Measurement of Electricity.—No proper conception of the economical production of the electric light can be arrived at without careful and accurate measurements of the quantities of electricity used. Dynamo machines are now brought to such a state of perfection that their commercial efficiency can be determined to an accuracy of 1 per cent. Thus the ratio of the useful work done outside the engine room to the work put in inside can be so accurately determined and even guaranteed by manufacturers, that when once we can measure the strength and potential (or pressure) of the electric currents flowing in the circuit we can calculate the quantity of coal that should be burned in the furnace to produce them. There are no physical quantities that can be determined with such marvellous accuracy as electrical effects, but curiously enough the more minute these quantities the more accurate the result, and the larger they are the more difficult the measurement and the less reliable the apparatus at our command. The measurement of gas or water used for any purpose is very easy. Meters are made which record accurately the quantity of each fluid flowing through, whatever be the pressure, and which record therefore the rate of flow, but in using electricity we require to know the pressure producing the flow, and the strength of the current, or the rate of this flow, to determine the energy consumed, or the work done in the circuit. Gas passes through the meter and is all utilised—a little may leak, but its presence is soon detected. Electricity, however, may be wasted in an unknown and unseen manner, unless a careful watch is kept on its performance. It was therefore essential that an accurate measurement of the electrical pressure and of the strength of the electric currents used should be determined. The pressure is expressed in terms of a unit called a *volt*, which is about the electromotive force of one cell of an ordi-

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nary Daniell battery, and the strength of the current is expressed in terms of the ampere, which is about the current used in an ordinary 20-candle glow lamp. The product of these two quantities, or the volt-amperes, which is the measure of the rate at which energy is consumed in the circuit, or of the power expended, is expressed in terms of the watt. The watt is a most valuable unit of power for electrical purposes. A horse-power is too large a unit of power. The watt is 1-746th part of a horse-power, or in other words, the horse-power is equal to 746 watts. A man rowing a race exerts about 100 watts, while in ordinary work, such as turning a handle, he works at the rate of about 60 watts. A sperm candle while burning develops about 90 watts—a man's power—while a common gas lamp develops 67 watts per candle. An arc lamp develops only 1 watt per candle, while the best glow lamp of the present day develops about 2·5 watts per candle. Hence the little heat produced by the electric light and the wide field for economy there is in its production. Few realise the waste of energy in gas light, or consider its proper function, viz., the production of heat and of power. The practical instrument used to measure the electrical pressure is called the *Volt meter;* that to measure the current the *Ampere meter;* that to measure the energy consumed the *Watt meter*. Absolutely reliable instruments of these kinds have not yet been produced, so that where accuracy is essential laboratory experiments must be made. There are many kinds of instruments in the market; too many in fact. Every engineer seems ambitious to devise a new form. This is perhaps one proof of their want of reliability. Of Volt meters I have used:—Sir William Thomson's, Cunynghame's, and Cardew's; of current meters:—Siemens', Thomson's, Ayrton and Perry's, Cunynghame's, and Upperborn's. Of Watt meters I have used none, for I have obtained sufficiently accurate results by multiplying together the volts and amperes. Some of these instruments, though equally practical and useful, required frequent verification and calibration in the laboratory. For simplicity, accuracy, and constancy, Cardew's volt meter leaves nothing to be desired, and latterly it was the only one I used. For large currents nothing can surpass Thomson's or Siemens', while for smaller currents Ayrton and Perry's is admirable. As an example of the mode of taking electrical measurement, I give the following results:—

Wimbledon, 20th May, 1884. Three 50-candle Woodhouse and Rawson lamps in one group.

Observation.	Electromotive Force in volts.	Current in Amperes.	Watts per lamp.
1	52	7·5	130
2	52	7·5	130
3	56	6·9	128·8
4	56	6·9	128·8
5	48·5	7·8	126
Mean per lamp.....	52·9	2·4	128·7

4. The Distribution of Electricity.—By this term is meant the arrangement of generators, conductors, and lamps, so as to obtain steady light with the least expenditure of energy, the smallest weight of copper, and the most economical form of lamp. Steadiness of light depends on constant pressure, and this is now obtained without any difficulty by perfectly governed engines and compound-wound machines. It is also obtained by using secondary batteries as regulators. The crux of electric lighting consists in its mode of distribution. The Electric Lighting Act of 1882 contemplates three modes of distribution, viz., the Series, the Parallel, and the Charging systems. A familiar type of the first—the Series system—is the Brush arc system, as used in the city of London, where as many as 40 arc lamps are joined up in series, or succession, on one continuous wire. An example of the second—the Parallel system—is found in the Edison installation on the Holborn Viaduct, where two thick main wires are carried through the area illuminated, and smaller leads are tapped off these conductors in a parallel fashion to act as minor conductors to each house, and again to each room, and again to each lamp. I know of no practical example of the third system as defined in the Act of 1882, though an important modification of it has been introduced into Colchester, to which I shall refer. The Series system is limited in its application. It has the disadvantage that, if one link in the chain breaks down, if one lamp goes out, all must simultaneously become extinguished, for the current will be stopped, unless special apparatus, acting automatically, cuts out each lamp as it fails, and thus restores the circuit. It involves the use of high tension currents, and therefore it means danger to person, unless perfectly protected. It has, however, the great merit of requiring light or inexpensive conductors. It is inapplicable to the ordinary incandescent system, though, as I shall show, a new glow lamp—the Bernstein—can be worked on this plan. The Parallel system is unlimited in its character, though the weight of the conductors increases as the area illuminated increases, in an increasing ratio which renders it impracticable to apply this system to any but small districts. An eminent consulting electrician recently pointed out that to supply an area requiring 100,000 lamps it would be necessary to have two copper bands nearly 31 yards wide and ·4in. thick. Such conductors would weigh 3,950 tons, and cost £1,500,000 per mile. If in full work they would actually waste energy at the rate of 6,750 horse-power, costing £65,000 per mile per annum. Such enormous conductors and such fearful waste render the parallel system pure and simple financially impracticable. The charging system is a system of decentralisation. It contemplates the use of currents of very high tension—4,000 volts—generated in a central station and conveyed along conductors to sub-centres, where they are employed in charging or exciting secondary batteries or accumulators, used as a store of energy, for the purpose of further distribution at a lower pressure into the houses on either the series or parallel system. The charging system, if it were practical, would remedy all the defects of the parallel system. High tension currents render small conductors practical, because they involve the use of small currents, but unfortunately the use of secondary batteries as accumulators has not yet been proved to be a practical success, and therefore this system has not yet had a fair trial. Were these batteries to prove successful, nearly all the difficulties in electric lighting would vanish. A wire the size of a lead pencil would replace the massive conductors required by the parallel system, and electric lighting would become a financial success. There are certain modifications of these systems of distribution which require examination. Dr. Hopkinson in England, and Mr. Edison in America, have considerably diminished the costliness of the parallel system by joining up two dynamos in series, and by introducing a third wire between them, which has allowed twice the electromotive force to be employed. It has thus diminished the total

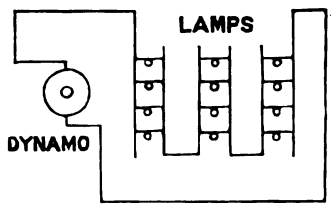

Fig. 1.

weight of copper used by five-eighths, that is, three-eighths of the copper required by the simple parallel system is all that is now needed for this new system. All central station systems put up by Mr. Edison in the United States are, I am told, installed on this plan. I do not know of its use in England. Indeed, there is no central station now at work here. This principle of multiple conductors admits of considerable extension. Dr. Fleming has shown that the economy effected is given by the formula:—

$$\frac{M}{2(M-1)^2},$$

M being the number of conductors, so that if five conductors were used, only 5·32 of the copper which would be required by the simple parallel system would be necessary. There is another serious difficulty in distributing electricity practically, and that is the diminution of electric pressure as the distance increases from the source of power, or as the number of lamps used varies. Lamps of different qualities have to be used in different parts of the circuit, if on the parallel system, to maintain equal efficiency. Thus, while on the Holborn Viaduct 110 volt lamps were used, at the General Post Office 90 volt lamps could alone give an efficient effect. There are two modes of distributing currents in practical use on a small scale, which tend to remedy these defects, the one at Brighton by the Hammond Company, and the other at Colchester by the South Eastern Brush Company, the one at Brighton being regulated by electro-magnetic devices, that at Colchester by secondary batteries. The system in use at Brighton is called the grouping system. It was introduced at the Paris Exhibition of 1881 by Mr. Henry Edmunds in applying a Brush dynamo to light up a large number of Swan glow lamps in the Congress Hall. It is a combination of the series and parallel systems. Supposing a dynamo producing 2 000 volts and 10 amperes were used to illuminate glow lamps requiring 50 volts and 1 ampere to incandesce them, then by this system groups of ten lamps would be joined up in series of forty steps, as in Fig. 1.

Now if the dynamo be self-regulating, as all good dynamos should be, then if any group of ten lamps be suddenly extinguished without breaking the circuit no injury or inconvenience would ensue. On the other hand, if any one lamp of the group be broken accidentally, or extinguished purposely, then too much current would pass through the remaining nine lamps; their existence would be endangered, and if they all went out, the whole circuit would be broken, and all the lamps throughout the whole circuit would be extinguished. This happened, as will be shown further on, in Wimbledon. Very ingenious electro-magnetic devices are used in Brighton to throw other lamps or equivalent resistances into the circuit when any one lamp fails. Of course, where very high tension currents

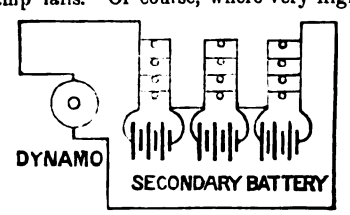

Fig. 2.

are used, there is danger to person if accidental contact is made with the wires conveying the currents; but this danger is reduced to a minimum when the wires are carefully insulated, and where the use of the earth is eschewed. The Board of Trade limits the electromotive force inside a house to 200 volts, but in the group system, while the total electromotive force may be 2,000 volts, it would be practically impossible for a person to touch two conductors at a higher potential with respect to each other than 50 volts. Circumstances might arise when, by the accidental use of the earth, the whole electromotive force might act on a person, but this is a contingency even more remote than that of a person walking deliberately with a lighted candle into a room full of explosive gas. A very important modification of this grouping system was used at Wimbledon, in which plain, cheap, and simple secondary cells were used as regulators

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instead of electro-magnets, as at Brighton. Each group had in addition to its quotum of lamps 25 secondary cells, connected as in Fig. 2.

At first the whole of the current would pass through the cells, in consequence of their low resistance, but it would speedily generate a counter electromotive force, and as soon as this electromotive force reached the maximum of the battery, which was that required to incandesce the lamp, the whole of the current would then pass through the lamp, and none through the battery. If a lamp broke, then the excess of current would pass through the battery, for the battery would prevent the raising of the electromotive force at the terminals of the lamps, which would be necessary to send more current through them, and therefore the current through them would remain steady. This quality of secondary cells is as valuable as their so-called storage power, and it requires only to be understood to be used. The system in use in Colchester is called the B. T. K. system, from the initials of Messrs. Beaman, Taylor, and King, who introduced it. Two large brush machines (known as No. 8), fixed in a central station, are used to charge secondary batteries placed at six different distributing points in the town. The houses and shops are supplied direct from these batteries. The automatic arrangements devised to stop charging when the batteries are full, and to direct the charging current to a second battery, are very ingenious. In fact the whole system has been worked out well, and it is an experiment that deserves very careful watching. I must confess, however, that at present I have no great faith in the commercial use of the present secondary batteries for the storage of electrical energy. As regulators they are already nearly perfect. Nevertheless, it is impossible to predicate what may be done with them. A novel and remarkable system of distributing by secondary generators, that of Messrs. Goulard and Gibbs, has recently been tried for a short time on the Metropolitan Railway. It is a modification of the charging system without the power of storage. A powerful alternating current dynamo, giving 1,500 volts and 11 amperes at one station—the Edgware-road—excited large induction coils or secondary generators at five other stations where secondary currents were employed to light up and regulate glow lamps in and about the stations. One hundred and fifty-one glow lamps and five Jablochkoff candles were distributed over a circuit eight miles long. The results obtained were surprising, and the efficiency of the apparatus proved to be very good. In selecting a mode of distribution for practical trial at Wimbledon, I had to take into careful consideration all the advantages and disadvantages of these different systems, and to select that which seemed to be the least objectionable. I had also to decide upon the use of a proper dynamo. The choice of a dynamo rested between alternate and direct current machines of high and low tension, some admirable examples of each of which are now to be obtained. The Ferranti alternate current machine is one of the most perfect machines, mechanical, and electrical, which has yet been manufactured, but it does not produce high enough tension for the purpose I had in view. In fact, my choice rested between the Brush and Hochhausen, and I chose the latter because its currents were more uniform and its efficiency apparently higher. This machine was exhibited at the Fisheries Exhibition of 1883 for the first time, and its performance there was very striking. Its behaviour has been admirable, and I am very well satisfied with it. The mode of distributing that I adopted was the grouping, each group being regulated by a secondary battery, as shown in Fig. 2. The working was very successful; the secondary cells kept the electromotive force of each group constant. If any lamp failed, the excess of current would pass through the cells, and not through the other lamps, whose light would remain steady and constant as long as only one lamp remained. Another advantage was that different kinds of lamps could be used at the same time. A current of 10 amperes was used, and this might pass through 10 lamps on one group, giving an ampere to each, or through five lamps taking two amperes each, or through one lamp taking 10 amperes, or any arrangement that would altogether take the whole current, the choice of the lamps for each group being quite independent of the electromotive force, as long as they required the same electromotive force in each group. This question of the proper distribution of currents is one of momentous consequence to the future of electric lighting, and it is one that is still in a tentative state. The Act of 1882 defined modes that are now obsolete. It is very necessary to watch carefully the result of the experiments that are being made at home and abroad, and I propose during my forthcoming visit to America to examine very carefully what has been done there. Unless a mode of distribution requiring light conductors can be proved to be practical, the financial success of electric lighting on a large scale is impossible.

5. The Wimbledon Experiments.—It was to determine the cost of production and to test practically the question of the measurement and distribution of light and of electricity for public street purposes that the experiments at Wimbledon were carried out. A commodious shed was arranged and placed at my disposal for an engine and dynamo room by the Local Board of Wimbledon. A portable agricultural steam engine of eight horse-power (nominal) was hired from Messrs. Wallis and Steevens, of Basingstoke. It was one of their standard pattern engines fitted with sensitive governors, such as is used at the British Museum for electric lighting purposes. The engine worked admirably and gave much satisfaction, but it was used far below its actual capacity, and therefore its consumption of fuel was not economical. This engine was connected by American oak tanned belting to a No. 4 Hochhausen dynamo machine, which was lent for the purpose by Mr. Henry Edmunds. The engine house was supplied with all the requisite meters and indicators to enable the electrical pressure and currents to be read at any moment. Two circuits, partially of solid No. 8 copper, and partially of stranded copper wire, made up of seven No. 16's, and giving a resistance of two ohms per mile, were supported on insulators fixed on ordinary scaffold poles placed at regular distances of 100ft. apart. The wire was lent for the purpose by Messrs. W. Glover and Co. The upper circuit extended through the Broadway, and up the hill to the High-street. The lower circuit extended through the Broadway, down the Merton-road and Gladstone-road, returning to the station by the Hartfield-road. Each circuit was about three-quarters of a mile long, and three miles of wire altogether were employed. The following table indicates the order and character of the experiments which were carried out:—

No. of Experiment.	Upper Circuit.	Lower Circuit.
1	20 c.-p. Swan lamps at 100ft.	20 c.-p. lamps at 100ft.
2	20 c.-p. Swan lamps at 200ft.	20 c.-p. lamps at 100ft.
3	10 c.-p. Swan lamps at 100ft.	20 c.-p. lamps at 200ft.
4	20 c.-p. Woodhouse and Rawson lamps at 100ft.	10 c.-p. lamps at 100ft.
5	50 c.-p. Woodhouse and Rawson lamps at 300ft.	10 c.-p. lamps at 100ft.
6	50 c.-p. Woodhouse and Rawson lamps at 200ft.	10 c.-p. lamps at 100ft.
7	50 c.-p. Woodhouse and Rawson lamps at 100ft.	10 c.-p. lamps at 100ft.
8	Bernstein lamps of various powers at different distances.	10 c.-p. lamps at 100ft.
9	Maxim lamps of various powers at different distances.	10 c.-p. lamps at 100ft.

A yard was especially set apart for experimental purposes, and each kind of lamp separately and carefully measured under various conditions. It would be tedious and unnecessary to describe in this report in detail all that was done and all the measurements that were taken. The programme was rigidly carried out. It will be more profitable to consider the results attained. No particular care was exercised to secure economy in the engine room. It is difficult to attain this in a temporary installation with an engine not specially designed for the work it is intended to do. Moreover, the expenditure involved in obtaining electrical power is so accurately known that there is no difficulty involved in getting it contracted for at a fixed price known to be just and fair, and therefore there was no object to be gained in studying carefully the efficiency and economy of the motive power arrangements. Horse-power developed by the engine can be converted into a definite number of electrical watts in the circuit, the cost of whose production is known, and to supply which responsible contractors could be found.

(TO BE CONTINUED.)

TELEGRAPHIC COMMUNICATION WITH THE EAST.

The following discussion on this subject took place in the House of Lords on Tuesday:—

Viscount Sidmouth asked whether the attention of Her Majesty's Government had been directed to the fact that the sole method of telegraphic communication with Hong Kong and some other British settlements in the East was by wires passing through a territory in the possession of a foreign Power; and whether it was the intention of Her Majesty's Government to adopt immediate measures to insure the safety of intercourse by electric telegraph with those parts. The question, he said, was one of great importance, and he hoped the Government had given their best attention to it.

The Earl of Derby said the noble Viscount was probably aware that there were two alternative lines of telegraphic communication between this country and Hong Kong. One of these lines passed through Russian territory in Siberia and down the Chinese coast to Hong Kong, and the other, from England to Singapore, which was more generally used, passed through Saigon, the French settlement, to Hong Kong. It was true that both these lines passed through foreign territory, but they did not both pass through territory belonging to the same Power; and if by any unfortunate event communication by one line was cut off there would still remain the other. He did not deny that there were advantages in having the entire line of communication in our own hands, but it made a considerable difference when we were not dependent on one line, but had the choice of two alternative routes not passing through the same territory. There was at the present time under the consideration of the authorities a proposal to make a line direct from Singapore to Hong Kong. That proposal was being considered by the various departments concerned, but he was authorised by his noble friend the First Lord of the Admiralty to say that the naval authorities, while not denying that such a line would be useful, did not regard it as of primary urgency, and they considered that the expenditure which would be involved might be more usefully employed elsewhere. At the same time that was the opinion of only one of the departments concerned, and no final decision had been come to by the Government as a whole. The consideration of the matter so far, however, pointed to the fact that this would be a most expensive line, as the cost of maintaining it would not be less than £20,000 a year; and in the next place, even if we had the line, it would not serve the purpose of carrying the whole communication in such a way as to avoid the territory of any foreign Power, because it would be necessary for that purpose to do that which had been often proposed—viz., to make an independent line of telegraph to Gibraltar and Malta.

The Earl of Carnarvon said that this question of submarine telegraphs ought not to be considered simply and solely on the ground as to whether the line would pay commercially. It must be remembered that these stations were valuable to this country, not only as great commercial emporia,

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but they were great military and naval outposts. He did not understand one remark of the noble earl; he had spoken as if there were no submarine telegraph between England and Gibraltar and Malta. There must be a mistake in the matter, as he himself had seen it at work. He wished to call attention to an important point in connection with this matter, and that was the extreme importance at this particular moment of the Government taking every precaution in their power against these submarine telegraphs being exposed to greater risks than necessary. It should be remembered that most of our commercial transactions at the present time were begun in the first instance by telegraph, and also that nearly all these lines were worked and managed by English capital. Commercially and politically, therefore, they were English property, and deserved every consideration at the hands of the Government. He wished also to point out that in time of war these submarine lines were exposed to very great and peculiar risks, while, on the other hand, through the development of modern science they could be easily repaired. The stores necessary to repair them should be close at hand and available. He sincerely trusted that during a time of peace, when the Government had full opportunity of making preparations, they had taken the necessary steps to secure an available supply of stores. There was not a large stock of telegraphic cable in this country, but it could be manufactured very rapidly when a certain stage of the proceedings had been arrived at. The matter was a delicate one, but he thought it right to remind the House and the country that in 1878, when there were great alarms as to a Russian war, the Russian Government, who were perhaps more alive to the circumstances of the case than we were, had taken measures for cutting the submarine cables and for equipping ships for that special purpose. It was said at the time and on good authority, and was generally believed, that there was a carefully elaborated scheme for taking measures against our submarine cables in the Eastern waters. It was quite right to mention these matters now, and he trusted that the Government had not been blind to the danger of leaving them unprovided for; but that while they had had the opportunity and a full warning they had taken those steps and those measures which might be necessary at any hour. [Hear, hear.]

The Earl of NORTHBROOK was understood to say that the question to which the noble earl referred was of a somewhat delicate character, and that if he thought it necessary to bring the matter to the notice of the Government it would have been more advisable to do so by means of a private communication [hear, hear.] If by making these remarks the noble earl meant to imply that those who were responsible for such matters were not alive to their importance, he was quite mistaken: What his noble friend had said was perfectly correct. There was a line, no doubt, almost entirely in English hands, to Malta, and so on to Hong Kong. He could assure the noble earl opposite that he was quite mistaken in supposing that the Government looked on these lines only from a commercial point of view, and, if he thought so, he must have misunderstood what had been said. There was no doubt that these submarine lines had other importance than mere commercial value. He could assure the noble earl that the Government had by no means shirked their responsibility in the matter [hear.]

The Marquis of SALISBURY said that the noble earl (the Earl of Northbrook) had applied a rather severe measure of interpretation to the language of his noble friend. In the first place, the noble earl (the Earl of Derby) not only did not say that there was a submarine line to Gibraltar, but exactly the reverse.

The Earl of DERBY, who spoke in a low tone across the table, was understood to say that he stated, in reply to Viscount Sidmouth, that there was no independent line to Gibraltar and Malta.

The Marquis of SALISBURY said there was another point which had not been noticed. It was a question whether commercial considerations were to be predominant over all others in these matters. The noble earl had simply stated that the colonies were not making this submarine line to Hong Kong, and that it would cost £20,000 a year. That was the very financial consideration which the First Lord of the Admiralty repudiated. But there was a point as to which he did not know whether it had attracted the attention of the Foreign Secretary, and it was whether the duty of a neutral was fulfilled if he conveyed a warlike message by telegraph. If there was any doubt upon that point the importance of submarine lines would become very great. He was not aware whether it had been decided; but he could easily imagine that if the neutrality of any Power towards us was not very benevolent difficulties might arise.

LIGHTING THE CITY.

At a recent meeting of the Sewer Commission the Streets Committee reported as to the contract entered into with the Hammond Electric Light and Power Company for lighting a part of the City by electricity, that the second £5,000, which was to have been deposited under the contract on Saturday last, had not been paid, that Mr. Hammond appeared anxious to carry out the contract, and that if the Money Market became more settled the company would be able to raise the necessary funds. The committee therefore recommended that the time for depositing the second £5,000 should be extended to June 11th, a period of two months.

Mr. TICKLE moved the adoption of the report. He did not think this was a very unreasonable request, considering the peculiar times when the raising of money for a public purpose must be a matter of considerable difficulty, especially when it was connected with electric lighting. The committee were most anxious to get electric lighting in the City [hear, hear], and a certain district was to be lighted up by the company, and he thought the committee should know the difficulties which surrounded the carrying out of any work for electric lighting, and the committee had endeavoured to assist the company to carry out the contract in every possible way. This was not a question of merely handing over the second £5,000. That was a small portion of the cost of accepting the undertaking. This installation would cost about £80,000, and before the company deposited a large amount of money like £10,000 they must be sure that they would get this £80,000. Whether they could get it remained with the company, but the committee asked for further time that they might have the opportunity [agreed.]

Mr. E. BELL asked the solicitor whether an embargo had been laid on the first £5,000 paid by the company [cries of "Agreed!"]

Mr. MOORE thought it not a fair question. Mr. Bell could obtain that information from the solicitor privately.

Mr. BELL pressed the question. He was simply asking whether that £5,000 was free and unfettered as far as the Company was concerned. He believed it was not.

Mr. MOORE was sure the Court would desire to give every facility to the company with a view of getting electric lighting. The company had acted throughout in a most fair and candid manner, and it was to the interest of the public that it should be assisted.

Mr. ALTMAN and Mr. SHAW urged that the question should not be put, and

Eventually the report was adopted.

Removals.—We are informed by Messrs. Frederick Young and Co. that, in consequence of the increase of their business, they have decided to transfer their office, show room, and works to the Prudential Works, Greville-street, Holborn, E.C. (situated in the rear of the Prudential Assurance Company's offices), and which they will shortly open.—In consequence of the increase of their business Messrs. Eck, Callow, and Co. have decided to transfer their office, show room, and works to the Prudential Works, Greville-street, Holborn, E.C. (situated in the rear of the Prudential Assurance Company's offices), and which they will shortly open.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. APRIL 15.		BUSINESS DONE WEEK ENDING APRIL 15. Highest.	Lowest.
Anglo-American	27,	28	27¾	—
Do. Preferred	48,	49	49¼	48½
Do. Deferred	6,	6½	6½	—
Brazilian Submarine	10⅞,	11	11	10⅞
Cuba	10⅞,	11¼	—	—
Do. Preference	17,	18	—	—
Direct Spanish	1¼,	2	—	—
Do. Preference	9½,	10½	—	—
Direct United States Cable	9,	9½	9½	9 1-16
Eastern Telegraph	11⅛,	11⅜	11⅜	11 5-16
Do. 6 per Cent. Preference	13⅛,	13⅜	13 11-16	—
Do. 5 per Cent. Debentures, 1899	105,	108	—	—
Eastern Extension	12⅛,	12⅛	12 13-16	12 5-16
German Union	9¼,	9⅜	—	—
Globe Telegraph and Trust	6⅜,	6⅝	6⅜	6 7-16
Do. Preference	12⅜,	12⅝	12½	—
Great Northern	13⅜,	14⅛	14⅜	13⅜
Indo-European	29½,	30½	30	29½
Reuter's	7½,	8	—	—
Submarine	175,	185	180	—
West India and Panama	⅝,	¾	¾	—
Do. 1st Preference	7½,	7¾	—	—
Western Brazilian	5½,	5¾	—	—
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅛,	⅜	—	—
Oriental	⅛,	⅜	—	—
United Telephone	10,	10½	10 9-16	10 1-16

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅜,	1⅝	—	—
Do. (fully paid)	2⅜,	8½	3 1-16	3
Hammond Light (£3 15s. paid)	⅛,	¼	5-16	¼
Swan	—	—	—	—
Maxim-Weston	⅛,	¼	—	—

MISCELLANEOUS.

Telegraph Construction	32½,	33½	33⅜	32⅜
India Rubber, Gutta Percha, and Telegraph Works	21,	22	21⅜	21¼

TRAFFIC RECEIPTS FOR MARCH, 1885.

COMPANIES.	March, 1885.	March, 1884.	Increase.	Decrease.
Brazilian Submarine	2,982	—	—	—
Cuba Submarine	3,500	3,296	204	—
Direct Spanish Telegraph	1,455	1,764	—	309
Eastern Extension	46,193	41,351	4,842	—
Eastern Telegraph	68,296	67,285	1,011	—
Great Northern	23,200	—	—	—
West Coast of America	4,290	—	—	—
Western and Brazilian	2,394	—	—	—

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NOTES.

THE BERLIN TELEGRAPHIC CONFERENCE.—The opening of the Telegraphic Conference at Berlin will take place on the 10th of August.

THE AUSTRIAN TELEGRAPHS.—The Austrian Government opened on the 1st of April a new telegraph office at Fürthof, in Lower Austria.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 17th inst. amounted to £3,605.

THE TELEGRAPHS IN THE FAR EAST.—The people of Singapore are also arranging for their defence, and are pressing for torpedo boats and a direct cable.

ELECTRICITY AND MEDICINE.—During the past week an examination of the cancer in General Grant's mouth was made by means of a small incandescent lamp.

TELEGRAPH BLUE.—Not content with having given us an "electric" colour, Paris is once more to the front with a new shade of blue, called "Telegraph blue."

THE SOUDAN TELEGRAPH LINE.—The military telegraph wire has been laid from Souakin to the front, so that there is constant communication between the two points.

THE RUSSIAN TELEGRAPHS.—A telegram from St. Petersburg, dated the 23rd inst., notifies the opening of a telegraph station at Kachka, in the Trans-caspian territory.

THE EASTERN AND SOUTH AFRICAN TELEGRAPH COMPANY.—This Company notify that a mail steamer is advertised to leave Zanzibar for Mozambique on Saturday (to-day).

THE CASPIAN SEA CABLE.—A telegram from St. Petersburg, dated the 21st inst., says:—"The Caspian Sea cable is interrupted, and trans-Caspian telegrams are forwarded *vid* Persia."

THE TELEPHONE IN PARIS.—There have been opened during one week in Paris, by the Société Générale des Téléphones, nine new call offices. The number of such offices available in Paris is now 68.

THE SPANISH TELEGRAPHS.—Early on Sunday morning last the telegraph lines were cut between Madrid and Saragossa. The perpetrators have not been discovered, but no importance is attached to the incident.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 15th April are £3,980, as compared with £3,221 in the corresponding period of 1884.

VOLCANIC ERUPTION IN JAVA.—It is reported from the Hague that an eruption has taken place of Mount Smeroe, the highest volcano in Java. Much damage has been done to the residences and coffee plantations in the district.

SALE OF PLANT.—We are requested to draw attention to the fact that it is the surplus mechanical plant, and not the electrical plant of the "Pilsen-Joel" and General Electric Lighting Company, which is to be sold by public auction.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 17th inst. were £2,897, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

"TECHNOLOGICAL DICTIONARY."—We have received the second part—German-English—of the new "Technological Dictionary of the Physical, Mechanical, and Chemical Sciences," published by Messrs. Symons and Co., of 27, Bouverie-street, London, E.C.

SMELTING BY ELECTRICITY.—The Cowles Electric Smelting and Aluminium Company of Cleveland, with a capital stock of $200,000, was incorporated at Columbus recently. The object of the company is the extraction, by means of electricity, of aluminium on a commercial basis.

IMITATION PLATINUM.—The appearance of platinum may be given to copper by immersion in a bath composed of 1¾ pints hydrochloric acid, 7½oz. arsenic acid, and 1¼oz. acetate of copper. The article must be cleaned before immersion, and left in the bath till it has the colour of platinum.

TELEGRAPHIC COMMUNICATION WITH THE ISLE OF MAN.—The screw steamer "Monarch" is engaged laying a new cable between the island and St. Bee's Head, and telegraphic communication is entirely suspended; but the work will, it is expected, soon be completed, and communication restored.

THE AUSTRALIAN TELEGRAPHS.—A telegraph office has been opened at Wandiligong, Victoria, South Australia. Mr. H. D. Willcox, postmaster and telegraphist at Alexander South, in Vincent County, has been brought before the local court and remanded on a charge of embezzlement of public moneys.

THE ELECTRIC LIGHT AT THE PALAIS ROYAL.—A syndicate formed by the tradesmen of the Palais Royal in Paris has decided to light the shops, the galleries, and the garden by electricity. The central station in which the necessary works are to be commenced as soon as possible will be arranged for 3,000 incandescent lamps.

SIXPENNY TELEGRAMS.—Down to the time of our going to press the Postmaster General's scheme for altering the inland telegraph tariff had not come on for second reading in the House of Commons. It was understood, however, that the Bill would be withdrawn if Lord John Manners's amendment for retaining full addresses be carried.

THE MEDITERRANEAN EXTENSION TELEGRAPH COMPANY.—The liquidators of this company announce that the transfer books of the company will be closed for five days from 20th inst. prior to a distribution among the ordinary and preferred shareholders of £2 per share of Eastern Telegraph Company's Four per Cent. Mortgage Debenture stock.

THE ADMIRALTY TELEGRAPH WIRES.—The Admiralty have informed the dockyard authorities at Devonport that during the present state of public affairs the use of the Admiralty telegraph wires is to be reserved for the more immediate purposes of the fleet of vessels being got ready for sea and for other matters of pressing importance in relation thereto.

OVERHEAD WIRES.—At a recent meeting of delegates from the various metropolitan vestries and district boards of works held at Lambeth Vestry Hall, resolutions were passed declaring that it was desirable, in the interest of the inhabitants of the metropolis, and as a general principle, that all telephone and telegraph wires within the metropolitan area should be placed underground.

THE TELEGRAPH IN ARABIA.—A telegram from Jeddah, dated the 20th inst., says:—Advices from the interior state that the Turkish troops occupied in laying the telegraph wire between Mecca and Taif were recently attacked by the Arabs inhabiting the district. In consequence of this affair the Turkish Government has resolved to pay an annual subsidy to the tribes for the maintenance of the telegraph between Mecca and Taif.

THE HUGHES TYPE-WRITER.—A well-known French electrician, M. Duplay, has replaced the old system of pedal-

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winding in the Hughes type-writer by a small automatic electric motor, which enables the pedals at present in use to be dispensed with. This motor is automatically placed in the circuit of a battery, or of a dynamo, at the precise moment when the weights have finished their descent, and causes them to reascend.

ELECTRIC LIGHT FOR STEAMSHIPS.—The steamship "Canada," belonging to the Compagnie Générale Transatlantique, received before her departure for Tonkin an experimental installation put in by Breguet. This consisted of 36 Edison 16 candle-power incandescent lamps, distributed in the saloon, the companion ways, the ladies' boudoir, and the smoking room. The current was supplied by a Breguet dynamo, driven by a small engine of six horse-power.

VOLUNTEER TELEGRAPHISTS AND THE WAR.—A further detachment of the field telegraphists of the 24th Middlesex (Post Office) Rifle Volunteers has been ordered to prepare for immediate embarkation for Egypt. In the event of a war with Russia it is considered probable that these men will proceed to India. The reserve corps of telegraphists from which this detachment is being drawn has recently been augmented by nearly one hundred enlistments.

BOLLMANN'S REDUCER.—A valued correspondent, writing from Vienna, informs us that amongst the apparatus upon which Mr. Bollmann is now engaged is a so-called "reducer" for effecting the conversion of currents of high E.M.F. to currents of low E.M.F., somewhat after the Gaulard and Gibbs, or, more recently, the Tipernowsky and Déri arrangements. Bollmann's contrivance, however, works with a continuous current in the primary circuit, which, on the face of it, seems to be in itself a distinct advantage.

NEW ELECTRIC LIGHTING COMPANIES.—The New Lots (N.Y.) Electric Lighting Company was incorporated at Albany, N.Y., on the 6th inst., with a capital of $15,000. The "Eastern Electric Company," with a capital of $250,000, has also been formed at Elizabeth, N.J., for the purpose of the introduction and sale of Van Depoele electric motors for surface and elevated roads. A tower 150 feet high will be constructed in the principal part of the city, the lights from which (four in number) will, it is claimed, throw a brilliant light 2,000 feet.

AN EDISON EXHIBIT AT PARIS.—At the late meeting of the Société Internationale des Eléctriciens, a minature dynamo was exhibited by the Edison Company, designed for small installations or for charging accumulators. It was capable of furnishing at 2,200 revolutions a current of 15 amperes and 50 volts at the terminals, and of lighting 20 Edison incandescent lamps of 8 candle-power. The total weight of the machine was 50 kilogrammes = 110lbs.; the intensity of the magnetic field 1,820 c.-g.-s. units; and the effective horse-power absorbed about 1·5 when at full speed.

ATTEMPTED ASSASSINATION.—An attempt to assassinate Mr. Geo. L. Masters, manager of the Telephone Exchange, was made yesterday, says the Evansville (Ind.) *Public*, of April 1st, and for a time there was much excitement in the neighbourhood of his office. Mr. Masters had been seated at his desk, and had just risen to answer a telephone call when a shot was fired through a window, passing within less than a foot of him. The ball passed through a glass partition separating his office from an adjoining room, and deeply imbedded itself in the wall beyond. The scoundrel immediately fled, and though pursued, managed to make good his escape. Mr. Masters has no suspicion as to the identity of his would-be assassin.

THE ELECTRIC LIGHTING OF THE BANK OF FRANCE IN PARIS.—It was not until after nearly three years' experience in the offices of the Bank with 180 Edison lamps that the governor of that establishment decided upon the final adoption of the electric light. That decision has resulted from its unquestionable superiority to gas. The new installation consists of two steam engines, by Weyher and Richemond, of 60 horse-power, and three Edison dynamos, of which two are of 500 lights and one of 200. In addition to this, the administration have retained the old dynamo of 200 lamps which they possessed in 1882, and which is put in motion by an engine in the printing establishment. The lamps in actual service number about 950.

LIGHT, OR DYNAMITE?—The *Pall Mall Gazette* says: Two German gentlemen arrived in London on Wednesday morning with a new invention in the shape of an electric light lamp, which they intended to submit to the chief of the Metropolitan Fire Brigade. At the Custom House, however, upon their baggage being searched, the officials thought they had come across an infernal machine, and promptly arrested the gentlemen and seized the invention. The unfortunate inventors were detained in custody all day, pending the verification by telegram of their statements. At a late hour they endeavoured to see Captain Shaw in order to explain their grievances. An appointment was made for Thursday morning, but the electric lamp had to go untested, for the officials had sent it to Woolwich.

WANTED—A NEW WORD.—Mr. Charles Curtoys, of the Consolidated Telephone Company, writes to the *Pall Mall Gazette*, as follows:—"The telephone is now coming into such general use that we begin to want a word for reference to denote messages sent, or received, by that means. Thus we have 'cablegram' and 'telegram,' or even 'wire'—all, by the way, words of rather doubtful authenticity, though answering their purpose. To meet the present requirement, I would suggest (for the purpose of discussion) 'telephoneme'—that is, 'a voice from a distance.' 'Telepnone' would be shorter, and perhaps as explicit, but means unfortunately, in some languages, the telephone itself." Our contemporary suggests, why not "telephonam," or "telepham," for shortness, as we have "telegraph" and "telegram"?

THE NATIONAL TELEPHONE COMPANY.—We have received the April list of subscribers of the above company in the Glasgow district with the important additions of the last few months. The book has been rearranged, and a description is given of some new services of a useful nature. Exchanges have been opened in Dumbarton and Hamilton, and communication can now be given with these places in addition to those formerly, viz., Greenock, Paisley, and Edinburgh; arrangements have been made with the postal telegraph department by which subscribers can receive their telegrams by telephone as well as by the usual way, and can also send their telegrams by telephone, the charge being, in addition to the usual rates charged by the Post Office, 1½d. for each message despatched, and 1½d. for each message received.

SYNCHRONOUS TELEGRAPHY.—Probably the most extraordinary proof of practically absolute synchronism was demonstrated by the experiment recently made by Mr. Delany over the line between Boston and Providence, whereby a single dot was transmitted from Boston to Providence and automatically repeated back and forth over the same wire at practically the same instant of time, travelling over different circuits in rotation backward and forward for the duration of five minutes, during which time it travelled 450,000 miles, this time, of course, being almost wholly represented by the movement of the armatures of the instruments. When we consider, however, the conditions involved in the transmission of a single dot, as in the case of the letter *e*, already referred to, the

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extent of perfection of the synchronism obtained will be understood.

ELECTRICITY AND WARFARE.—We are indebted to a French contemporary for the information that the Russian Minister of Marine has given orders for the equipment, at Cronstadt, of several fast launches with a powerful electric motor which will be actuated by accumulators of a new kind, invented by an officer of the "Ivéritinoff." The launch constructed by the inventor and submitted to the Russian authorities is said to be capable of running at a speed of 20 miles per hour for five hours. Great things, says our contemporary, may be expected, more especially in regard to night operations, from armed launches of this kind, working without noise, without smoke, and without light. One very serious drawback, however, is the limited nature of the distance covered. We should have expected from a Russian inventor a motor of much more extended capabilities. One hundred miles per hour for a week would have been better and more characteristic of the nation.

ELECTRO-MAGNETIC MILLING.—Here, says the *Milling World*, is the latest idea as to electrical application. The head miller sits in a handsomely carpeted and luxuriously furnished office, his feet easily thrown up on a desk-like structure before him. Within easy reach are a series of electrical buttons, over which are designating words. To his left are a series of electrical bells, also provided with designating words. Now, a farmer drives up with a load of wheat, and the scale bell tinkles the fact to the head miller, who, with his right hand, presses the button which opens the door to the scale hopper. The farmer dumps his wheat therein, and its weight is at once shown up to the head miller by figures electrically displayed. While this is being done another bell rings, and the words "Feed Out," or "Spout Choked," or other specifying phases are shown him, and he, by simply pressing the proper button, remedies all difficulties, and continues smoking. Pretty nice outlook for the dusties, don't you think so?

THE NEUMAYER TELEPHONE RECEIVER.—In the receiver of M. A. Neumayer the magnet is formed by five small bars of the best quality of English steel. In order to obtain an increase of mobility in the magnetism, the inventor employs a bundle of very fine iron wires in connection with the pole nearest to the membrane. Towards its centre this bundle is soldered to a brass socket, a small part of which makes good contact with the magnetised rods, while the other part supports the coil, which has a resistance of about 100 ohms. To avoid the variations of distance, which are in effect variations of temperature, between the pole and the diaphragm he has a plate of brass soldered to the centre of the bundle of wires, to screw upon the box carrying the vibrating plate; this box is of brass, and the diaphragm, of a thickness of three millimetres, rests upon a a breadth of two millimetres upon the upper part of the box. The magnetised bars are maintained in a brass ring, which has a corresponding number of grooves.

PROPOSED CABLE BETWEEN WESTERN AUSTRALIA AND THE MAURITIUS AND NATAL.—The Mauritius correspondent of the *Natal Mercury* says:—"The question of laying a cable from Western Australia to Mauritius and Natal has just been referred to a full committee of the Council of the Government. Some fears were entertained by Sir James Anderson that the weather is so bad between the Australian coast and Cape, *viâ* Mauritius, as to render it next to impossible to effect repairs in the cable. Before submitting the papers to Council, they were referred to an able meteorologist, Dr. C. Meldrum, F.R.S., for his opinion on the question raised as to the meteorological and physical difficulties that are alleged to exist in the way of repairing and maintaining the cable in the sea between Australia and Mauritius. Dr. Meldrum has given it as his decided opinion, based on close observations, extending over thirty years, that, as regards storms, a telegraphic route to Swan River or North-west Cape to Natal, *viâ* Mauritius, would be safer than the telegraphic route between Ireland and Newfoundland."

AN ELECTRIC RAILWAY IN MARYLAND.—We notice in the *Maryland Journal* that the Union Passenger Railway Company, of Baltimore, has commenced the building of a branch connection to Mount Vernon, Hampden, and Woodbury, in which electricity will figure as the motive power. The electric conductor will be a third rail laid in the centre of the regular rails. The cars will be drawn by motors with electric machinery. The contact between the electric rail and the motor is by a wheel, which runs over the rail. A motor, independent of the cars, is being made to try the experiment, and if it is successful, it is likely that the future motors will be part of the cars, so that one man may run the motor and act as collector of fares. It is claimed for the new system that it will be cheaper than horses; that there will be no noise, no smoke, and no cinders, and that it will run from eight to ten miles an hour. The pressing of a finger against a button is all that is required to manage the motors. The length of the new road is two miles and a quarter, and it is expected to be ready for use about the middle of this month.

DOMESTIC ELECTRIC LIGHTING.—The seat of J. Wilson, Esq., Daramoun, County Westmeath, Ireland, has recently been lighted by means of the electric light, the motive power being derived from a small waterfall situated about half a-mile distant. The lighting is effected with incandescent lamps working off Frankland accumulators, to which the current is supplied during the day by a dynamo driven by a turbine. At a ball given recently the ball room was brilliantly lighted by the electric light. No fittings whatever were employed, the incandescent lamps (20 candle-power) being supported upon the shrubs, trees, and floral decorations of the room. A very pretty effect was introduced by placing some of the lamps in large bowls containing tinted water; while another and more quaint effect was given by a number of looking glasses in moss and ivy, into which lamps of 10 candle-power were placed in such a manner that the lamps were invisible, the arrangement resembling small ponds of crystal. The work has been carried out jointly by Mr. W. E. Wilson and Messrs. A. R. Sennett and Co., by whom the accumulators, &c., were supplied.

CABLE COMMUNICATION WITH ASIA.—A correspondent of the *Colonies and India* writes as follows:—"In view of the present agitation in Hong Kong for independent and more direct communication, would not this be a favourable opportunity to advocate a trans-Pacific cable from Hong Kong to Vancouver, which will shortly be in direct communication with England? It appears to me that both commercial and military ends make it desirable. Canadian merchants will in future seek a large direct trade with the Orientals, and will require the most prompt information of their markets. At present (unless I am misinformed), they must cable Eastern Asia *viâ* Europe. As in railway traffic, cable tariffs have relationship to the length of line traversed, and delivery by a direct route is likely to be more efficient and stable than by one of a number of sections, sometimes passing through foreign territory. From a military point of view, the arguments applying to the Canadian Pacific Railway, as a valuable alternative in time of need, apply with equal force to the cable communication. Anyone who is not familiar with the relative distances by the eastern and western routes to China and Japan should refer to a map of the world to see how obvious is the advantage in the latter."

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THE INDO-EUROPEAN TELEGRAPH COMPANY.—This Company's report states that the revenue from all sources for 1884 amounted to £98,103. The expenses were :—On commercial and general account, £24,639 ; on maintenance account, £28,684, including £151 paid to the Russian Government ; total, £53,323. Deducting the above expenses, taking credit for balance brought over from 1883, and debiting income tax, there remains the sum of £43,571. From this amount, £10,625 paid for interim dividend, and £5,000 paid to Messrs. Siemens in final liquidation of their agreement of 16th July, 1868, have to be deducted, leaving a balance of £27,953 available. The Directors propose the declaration of a dividend for the last six months of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 10s. per share, making in all 8 per cent. for the year. The balance of £4,578 will be carried forward. The amount received on account of the Persian debt, £1,986, constitutes the first payment on account of the item of £21,846 standing to suspense account, which will be gradually liquidated by similar annual deductions from the royalties payable by the Company to Persia.

THE ELECTRIC LIGHTING OF THE LIBRAIRIE HACHETTE IN PARIS.—The large workshops of the Librairie Hachette in the Rue Stanislas in Paris are now completely and effectively lighted by electricity. The installation comprises about 400 incandescent lamps variously distributed, the current being supplied by one dynamo of 200 lamps, and two of 60 lamps each. These are actuated by a motor of 50 horse-power. The principal dynamo, which is placed in a position about 20 metres distant from the others, is driven by a machine of 25 horse-power specially devoted to this installation, and which, in case of accident, can be utilised to drive either or all of the three dynamos. The boiler of this machine is always under pressure during the day for various purposes connected with the Librairie. When it is necessary to light up, the machine can be put in motion in a few minutes. The lighting can be effected either with one dynamo or with the three coupled in multiple arc. The 60-lamp dynamos are by Edison, of the pattern shown in the Electrical Exhibition of 1881, while that of 200 lamps is a new model, giving a current of 150 amperes, with a tension of 120 volts at a speed of 1,300 revolutions. The internal resistance of the coil is 0·023.

THE ROYAL VISIT TO IRELAND.—The *Standard* says :—"Rarely has a nobler entertainment been offered to guests of any rank than that which was given to the Prince and Princess of Wales on Monday evening by the Citizens' Reception Committee. The committee made all their arrangements on the most colossal scale, and such a ball has certainly never been seen before in the Irish capital. The vast halls of the Royal Dublin Society, in which the agricultural shows are held, were placed at the disposal of the promoters, and they succeeded in effecting a most astonishing transformation in the aspect of the interior of the building. Instead of the bare whitewashed walls and uncovered floor, which are the familiar characteristics of the place, the guests were surprised to find a beautifully decorated ball room. The supper room presented a scarcely less ornate appearance. All the tables, that set apart for the Royal guests especially, glittered with glass and silver, which sparkled in the soft light shed by the hundreds of electric lights with which the building had been fitted up for the occasion. The space in front of the Royal table was ornamented in the most profuse manner with flowers and plants and beds of moss, and no feature in the scheme of decoration presented a more beautiful appearance than this."

A NEW SYSTEM OF TIME.—From a paper read by Prof. Loudon before a meeting of the members of the Canadian Institute, Toronto, Canada, we extract the following :—The present day of 24 hours would be divided into ten divisions, so that each hour, if we might so call it, on the new system would correspond to 2 hours 24 minutes. This hour would be again divided into 100 divisions, called minutes if necessary, each minute on the new system thus corresponding to 1·44 minute, a good fractional unit. Again, this new minute division could be subdivided for accurate measurements into 100 divisions, called seconds. The advantages arising from such a system would be : 1. The abolition of the so-called a.m. and p.m. nuisance—what has already been accomplished by the 24 hour system. 2. All the advantages to be derived from the adoption of any system based on our scale of 10—namely, the inconveniences arising from the continual use of vulgar fractions and the use of symbols for each unit in the ordinary affairs of life. 3. The fact that the time in hours and minutes (which for all practical purposes is sufficient) is indicated immediately by the clock. This is the most important advantage, because in the present system we have always to multiply by five before we know the time—thus 1 means five minutes past, 2 means ten, 11 means fifty-five past, or five to, and so on ; and this would really overcome, said the professor, the great difficulty experienced by most children in learning to tell the time.

THE SHEFFIELD TELEPHONE EXCHANGE.—Since October last year extraordinary activity has existed in this very successful private undertaking. At that time it was thought desirable to rearrange the rates of subscription, and the result has been exceedingly gratifying to the management. More than 100 subscribers have been attached to the Exchange during the past six months, and orders for attachment are still far ahead of the construction staff. A great improvement has also been manifested in the private wire branch of the system ; that is, in wires that do not pass through the Exchange. The Exchange and private wires now extend in various directions from ten to twelve miles around Sheffield. Over 13,000 messages per week are passed through the Exchange ; 11 call offices have been opened in the town and district, and five more call offices are about to be opened. The public are admitted to these call offices at a charge of 2d. and 3d. per conversation. The permission of every subscriber has been obtained to allow the free use of his instrument by the public in case of an alarm of fire or accident, and as this fact has been made well known a most complete and comprehensive fire alarm system is thus established. The business has now grown to proportions altogether too unwieldy for private enterprise ; and, as greater and more important developments are immediately contemplated, it has been decided to place the future of the Sheffield Telephone Exchange in the hands of a limited company.

THE TRANSMISSION OF POWER IN NEW YORK CITY.—A correspondent of the New York *Electrical World* writes as follows :—"The Electric Power Company, an organisation composed of some of the most prominent business men of New York City, have commenced active work, having purchased the rights of the Daft Electric Light Company for the counties of New York and Westchester. The Company take as a nucleus the plant put in by the Daft Company on Spruce-street, New York City, in January, 1884. This plant consisted of a six horse-power dynamo located in Buxton, Heims & Co.'s steam power plant, 13, Spruce-street. At first wires ran only to Nos. 32 and 33, Spruce-street. The motor there ran their elevator, its maximum load being 2,000 pounds. In March the plant was increased, another motor similar to the former being put in another leather house, next door to the

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above. This motor did similar work and ran in parallel with the first. These motors now show but trifling wear. The same armatures, the same commutators, the same everything, are to-day in use. The commutators of the motors have not yet been turned, the wear after a year's run not yet warranting it, although tons have been hoisted daily. Their run has been extraordinary. They demonstrate beyond all question their eminently practical qualifications for such work. Two weeks ago the Electric Power Company substituted one of the Daft Company's largest dynamos in place of the smaller one at 13, Spruce-street. It is their intention now to add as rapidly as possible to the plant. A large order has been handed the Daft Company for motors, aggregating some 30 horse-power. The business of the new company is in able hands, and we feel sure that a revolution of motive power in New York City has started. Economy of room, economy of money, are the desiderata. They will be realised."

THE TELEPHONE IN EUROPE.—Some interesting statistics of the telephone lines in Europe have lately been given by *L'Ingenieur*:—In Italy, at the end of 1884, ten towns possessed telephone lines as against the same number in the previous year, but the number of subscribers showed an increase of 30 per cent. Eleven towns in France had telephonic communication during 1883 and 1884, the number of subscribers increasing 15 per cent. Belgium, at the close of 1884, had five towns connected up; and an increase of 19 per cent. in the number of subscribers. In England, London had a similar increase of 25 per cent.; and Liverpool, Manchester, Southport, and Blackburn together, 17 per cent. In Sweden, in 1882, only five towns had the telephone; in 1884 there were fifty-one towns; and the number of subscribers showed an increase equal to 398 per cent. in the two years. Switzerland had ten towns in 1883, and twenty-seven in 1884; increase, 112 per cent. Russia had, in 1883, six, and, in 1884, seven towns; increase of subscribers, 60 per cent. In Berlin there were 1,500 subscribers in June, 1884. Austria possessed, at the end of 1883, eight cities with telephone lines; and there were 708 subscribers at Vienna in December, 1884. In Norway, on June 30th, 1883, Christiana and Drammén, with 755 and 150 subscribers respectively, were the only towns having such a system. In Denmark, Copenhagen had 516 subscribers in June, 1883. Portugal, at the end of 1883, had Lisbon, with 343 subscribers, and Oporto, with 183 subscribers. The following additional information has also appeared from time to time in our columns:—Denmark, Copenhagen, at the end of 1884 had 1,105 subscribers. England; Dundee, February, 1885, 400 subscribers. New Zealand; at the close of 1884, there were about 1,100 subscribers in the colony, and 100 country stations were open where the telephone is used instead of the Morse instrument. In Holland, in March, 1885, the Nederlandsche Bell Telephone Company alone had 2,400 names on their list. France; 68 call offices are now open in Paris. Germany; the telephone was introduced into this country in 1880; there are now 58 country exchanges, possessing a network of wires extending over a distance of 10,100 miles. San Domingo; an exchange was in course of erection in Puerto Plata last month. Spain; there were last month 80 places connected with the central station in Madrid. Phillipine Islands, at Jolo, between the outlying forts and the residence of the military governor. Mozambique Island, between the fort and the residency, put in in 1880.

UNDERGROUND WIRES AND CHOLERA.—Our American contemporary the *Sanitary Engineer* says:—"The New York City Board of Health has passed resolutions to the effect that the excavations necessary to place the telegraph wires under ground in one season, as required by law, would prove highly detrimental to the health of the city, and that street excavations should be avoided as far as possible during the coming summer, owing to the special danger of an invasion of cholera. We believe that this action of the Board of Health is unnecessary and unwise, but it is to some extent excusable on the ground of the communication addressed to the Board by certain prominent physicians of the city, advising against excavations in the streets for fear of cholera. We do not think that the physicians thus advising have sufficiently considered all sides of the complicated question which they have thus decided, and fear that they have been unduly influenced by the urgent appeals which have been made to them in the name of humanity, but really in the interests of those who wish to postpone the burying of the wires, and have given too little consideration to the danger and nuisance of leaving things as they are. From the present condition of the telegraph wires in this city it would be a practical impossibility to remove them entirely from above the streets between this and the first of November, but the idea that the work can be postponed and resumed after the first of November, to be stopped again the first of May, 1886, is absurd, since in all well-regulated municipal work in northern latitudes there is a provision in contractors' specifications that excavations shall not be made or trenches filled between the first of November and the middle of April. The Board of Health has evidently done too much for the telegraph companies, who would not care to make their excavations by blasting, nor would any engineer care to have a trench filled with chunks of frozen dirt, nor would any one enjoy a drive over a pavement laid on such a foundation. Except in certain down-town portions of the city, where several lines of gas-pipes and the steam-heating pipes with their several branches into various buildings will be met with, the trenches required for placing wires underground will be comparatively narrow and shallow, and need not be open for any length of time. The work should be proceeded with as soon as the frost is out of the ground, and we do not believe that the danger to the public health is worth considering in comparison with the increased comfort and security which the public would gain from having the work done."—Commenting upon this question the *Pall Mall Gazette* says:—"The organised effort to burke the compulsory order of Congress that all telegraph and telephone overhead wires in New York shall be placed underground before the 1st of November next has advanced another step. Having won over a certain class of physicians to professionally declare that the necessary excavations would lay the city open to the inroads of cholera, the affected interests have now got the New York City Board of Health to back up the physicians with a resolution declaring that the excavations necessary would prove highly detrimental to health, and should be avoided as far as possible during the coming summer, owing to the special danger of an invasion of cholera. Of course, once postponed till November, a further postponement over the winter would be easy, for it is a common provision in contractors' specifications in America that excavations shall not be made or trenches filled between the 1st of November and the middle of April. Then in the following summer yellow fever at Panama or Vera Cruz, or leprosy at Honolulu, or some other epidemic, could take the place of the cholera excuse, and the wires might swing for ever overhead, with the simple addition of the doctors' fees to the working expenses. But will Congress allow itself to be so playfully trifled with? We think not. Anyhow, the crisis will certainly become acute between this and the 1st of November next."

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ELECTROMAGNETIC INDUCTION AND ITS PROPAGATION.

BY OLIVER HEAVISIDE.

(CONTINUED FROM PAGE 431.)

Work done by Impressed Forces during Transient States.

When we charge a condenser by means of a voltaic battery a transient current is set up in the circuit, which is quickly stopped by the elastic reaction of the electric displacement in the dielectric. There is then a certain amount of electrostatic energy set up in the condenser, say U, and, during the charge, a certain amount of heat was generated in the conductor. That its value is also U (expressed as energy, to save the perfectly useless introduction of the mechanical equivalent of heat), may be seen at once on remembering that when we discharge the condenser through the same resistance (without impressed force), the current passes through the same series of values at corresponding times as during the charge, and must therefore generate the same heat, which, being now derived from the potential energy of the condenser, must amount to U. And we further see that whether the discharge circuit has or has not the same resistance as the charge circuit, the heat during the charge and discharge are equal, namely U. Thus, in charging the condenser, the battery does 2U of work, half of which is accounted for by the Joule heat during the charge, and the other half by the energy of displacement in the condenser.

This property is wholly irrespective of the manner in which the charge takes place, if no other work be finally done than in heating and in setting up electrostatic energy. Thus a coil may be inserted in the circuit, which may materially alter the manner of the charge, and render it oscillatory; still, the heat will amount to U as before. And if we put another coil near the first, so that there is a current during the charge in it as well as in the main circuit, the heat will still be exactly U, provided we include the heat in the secondary coil as well.

Similarly in charging a submarine cable, the distant end being insulated or only connected to earth inductively through condensers, so that the final state is one of no current (practically), the total heat during the charge exactly equals in value that of the electrostatic energy set up in the dielectric of the cable, condensers, etc., when we count the Joule heat in the conductor, sheath, and wherever else there may be conduction current during the charge.

The general law, of which the above are examples, is as follows:—If, in any arrangement of matter, conducting (metallically), or dielectric, or both, originally uncharged and free from current, we cause any steady impressed forces to suddenly commence to act, and we keep them on, whose distribution is such that the final state is one of no current, the Joule heat generated in the conducting parts during the transient state will exactly equal in amount the value of the final electrostatic energy set up. The impressed forces may be either in the dielectric or the conducting matter. If in the former, it does not matter how they are distributed, for the final state will be one of no current; but if in conducting matter the distribution of impressed force ceases to be permissibly arbitrary. In a linear conducting circuit, for example, their sum must be zero round the circuit. If partly conductive, partly inductive, this ceases to be necessary, but the impressed forces must act equally over the whole cross-section of the conductor, otherwise the final state will not be one of no current.

Suppose, however, other things being the same, the distribution of impressed force is left perfectly arbitrary in the conductors as well as in the dielectrics, with the result that the final state is a certain distribution of steady electric current in conductors, of electrostatic energy in dielectrics, and of magnetic energy in both, all to be definitely known from the given data, the distribution of impressed forces, of conductivity, capacity, and permeability. This we may conveniently divide into three cases; first, the final magnetic energy negligible in comparison with the electrostatic; next, the electrostatic energy negligible in comparison with the magnetic; and last, the real case, both being counted.

In the first case we have a transient state of induction, during which the actual electric force anywhere is that due to the impressed force on the spot and the changing electrostatic force (though "static" is rather misapplied) with electric current, both in conductors and dielectrics, leading to a final state in which the current is confined to conductors. Now, if there had been no electrostatic capacity, the final state of current would have been set up instantaneously, the activity of the impressed forces would be $\Sigma e C_0$, a being the impressed force anywhere and C_0 the current, the summation to include all places where e exists. This activity would have existed from the first moment, so that at the time t after the putting on of the impressed forces, the whole work done by them would have been $t\Sigma e C_0$, wholly accounted for in Joule heating. In reality, when there is electrostatic energy set up as well, the whole work done by the impressed forces up to the time t, to include the transient state, exceeds the amount $t\Sigma e C_0$, which would have been done had there been no electrostatic energy to set up, by the amount 2U, if U is the final energy of electric displacement. Besides doing an additional amount of work U in setting up the energy of electric displacement, the battery does an equal additional amount, which is accounted for as extra Joule heating.

Thus, in charging a shunted condenser, or a cable whose further end is to earth (if we do not count the electromagnetic induction), U being the value of the final electrostatic energy, the battery will do 2U more work than if the electrostatic capacity were *nil*, half in extra heating, half in setting up the electrostatic energy.

In the second case we have a great difference. Here electromagnetic induction is predominant. The law is now (other things being the same) that the impressed forces do 2T *less* work than they would have done had there been no magnetic energy to set up, T being the value of the final magnetic energy. In the electrostatic case the work done was $t\Sigma e C_0 + 2U$; it is now $t\Sigma e C_0 - 2T$, up to any time t including the transient state. Hence the Joule heat (instead of being U more), is now 3T less than if no magnetic work had been done.

In both cases, U and T, the electric and magnetic energy, are recoverable, appearing as Joule heat in the conductors when the impressed forces are removed; but the doing of electrostatic work makes the impressed forces work faster, and of magnetic work slower. The one is potential energy, the other kinetic. The one is connected with elasticity, the other with inertia.

Lastly, coming to what is really always the case, both electric and magnetic energy set up. During the transient state the coexistence of the two inductions causes a singularly complex state of affairs, by no means the mere resultant of the two taken separately. Yet the law, which we might guess from the preceding, is that the additional work done by the impressed forces above the amount $t\Sigma e C_0$, that they would have done had there been no electric and magnetic energy to set up, amounts to $2U - 2T$, being 2U more on account of the electric energy U and 2T less on account of the magnetic energy T; whilst the Joule heat is increased by $U - 3T$.

This includes, of course, all the preceding special cases. Thus, in the case of charging a condenser, the final current $C_0 = 0$, and $T = 0$. The additional work $2(U - T)$ may of course be either positive or negative, according to the values of U and T.

The following proof covers the whole, the impressed forces being arbitrarily distributed, and the matter having any conductivity, capacity, and permeability. Also colotropy in these three respects is included.

Let e be the steady impressed force at any place, put on at the time $t = 0$, and kept on. Let E, H, Γ, G, be the electric force, magnetic force, electric current and magnetic current, at the time t after the commencement, and E_0, H_0, Γ_0, their final values, G_0 being zero.

The activity of e is $e\Gamma$ at any moment, and the total activity is $\Sigma e\Gamma$ through all space, or wherever e exists. Let F be any "polar" electric force, then

$$\Sigma F\Gamma = 0, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (55)$$

because F has no curl, and Γ no divergence; a well known theorem that is made visibly true by considering that the tubes of Γ are closed, whilst the line integral of F round any closed curve is zero.

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Now, in the transient state, the equation of induction is

$$\text{curl}\,(e-\mathrm{E}) = 4\pi\mathrm{G}\,; \quad \ldots\ldots \quad (56)$$

which becomes, in the final state,

$$\text{curl}\,(e-\mathrm{E}_0) = 0\,;$$

whence

$$\mathrm{E}_0 = e + \mathrm{F}_0, \quad \ldots\ldots\ldots \quad (57)$$

where F_0 is polar, or $\mathrm{F}_0 = -\nabla\mathrm{P}$; P being a scalar potential, the electric potential. Choose then $\mathrm{F} = \mathrm{F}_0$; then, by (55) and (57)

$$\Sigma e\Gamma = \Sigma e\Gamma + \Sigma\mathrm{F}_0\Gamma = \Sigma\mathrm{E}_0\Gamma\,; \quad \ldots \quad (58)$$

or the activity is the same on putting the final real electric force for the impressed force.

Now

$$\Gamma = \mathrm{C} + \dot{\mathrm{D}}, \quad \ldots\ldots\ldots \quad (59)$$

C being the conduction and $\dot{\mathrm{D}}$ the displacement current, D being the displacement (elastic). Therefore, by (58) and (59),

$$\begin{aligned}\Sigma e\Gamma &= \Sigma\mathrm{E}_0\mathrm{C} + \Sigma\mathrm{E}_0\dot{\mathrm{D}},\\ &= \Sigma\mathrm{E}_0 k\mathrm{E} + \Sigma\mathrm{E}_0\dot{\mathrm{D}}, \quad \text{because } \mathrm{C} = k\mathrm{E}\,;\\ &= \Sigma\mathrm{C}_0\mathrm{E} - \Sigma\mathrm{E}_0\dot{\mathrm{D}}, \quad \ldots\ldots \quad (60)\end{aligned}$$

k being the conductivity, and $\mathrm{C}_0 = k\mathrm{E}_0$ the final conduction current, $= \Gamma_0$.

But

$$\text{curl}\,\mathrm{H}_0 = 4\pi\mathrm{C}_0\,; \quad \ldots\ldots\ldots \quad (61)$$

therefore,

$$\Sigma\mathrm{C}_0\mathrm{E} = \Sigma\,\frac{\mathrm{C}_0}{\text{curl}}\,\text{curl}\,\mathrm{E} = \Sigma\,\mathrm{H}_0\,(\text{curl}\,e/4\pi - \mathrm{G})$$

by (61) and (56). Therefore

$$\begin{aligned}\Sigma\mathrm{C}_0\mathrm{E} &= \Sigma e\,\text{curl}\,\mathrm{H}_0/4\pi - \Sigma\mathrm{H}_0\mathrm{G}\\ &= \Sigma e\mathrm{C}_0 - \Sigma\mathrm{H}_0\mathrm{G}.\end{aligned}$$

Putting this in (60), we get

$$\Sigma e\Gamma = \Sigma e\mathrm{C}_0 + \Sigma\mathrm{E}_0\dot{\mathrm{D}} - \Sigma\mathrm{H}_0\mathrm{G} \quad \ldots\ldots \quad (62)$$

This is true at every moment. Now integrate (62) to the time, from 0 to t, to include the transient state (t must mathematically be infinity), and we get

$$\Sigma e\int\Gamma dt = t\Sigma e\mathrm{C}_0 + \Sigma\mathrm{E}_0\mathrm{D}_0 - \Sigma\mathrm{H}_0\mathrm{B}_0/4\pi \quad \ldots \quad (63)$$

D_0 being the final displacement, B_0 the final magnetic induction. But

$$\mathrm{U} = \tfrac{1}{2}\Sigma\mathrm{E}_0\mathrm{D}_0\,; \quad \mathrm{T} = \tfrac{1}{2}\Sigma\mathrm{H}_0\mathrm{B}_0/4\pi$$

are the values of the final electric and magnetic energies. So (63) becomes

$$\Sigma e\int\Gamma dt = t\Sigma e\mathrm{C}_0 + 2\mathrm{U} - 2\mathrm{T} \quad \ldots\ldots \quad (64)$$

which is the required result, showing that the work done by the impressed forces is increased by 2U on account of the electric energy, and reduced by 2T on account of the magnetic energy, the Joule heat being increased by U − 3T.

I have written out the above rather fully. Without the explanations, it goes simply thus,

$$\begin{aligned}\Sigma e\Gamma &= \Sigma\,(e+\mathrm{F}_0)\,\Gamma = \Sigma\mathrm{E}_0\Gamma = \Sigma\mathrm{E}_0\mathrm{C} + \Sigma\mathrm{E}_0\dot{\mathrm{D}}\\ &= \Sigma\mathrm{C}_0\mathrm{E} + \Sigma\mathrm{E}_0\dot{\mathrm{D}} = \Sigma\mathrm{H}_0\,(\text{curl}\,e/4\pi - \mathrm{G}) + \Sigma\mathrm{E}_0\dot{\mathrm{D}}\\ &= \Sigma e\mathrm{C}_0 + \Sigma\mathrm{E}_0\dot{\mathrm{D}} - \Sigma\mathrm{H}_0\mathrm{G},\end{aligned}$$

whose time integral is

$$\Sigma e\int\Gamma dt = t\Sigma e\mathrm{C}_0 + 2\mathrm{U} - 2\mathrm{T}.$$

This shows how much may be put in a small compass.

We should remark that it is Γ the true current that is divergenceless, in general, not C or $\dot{\mathrm{D}}$ separately, except in the final state, when the current is wholly conductive. Also, that we twice make use of the theorem

$$\Sigma\mathrm{A}\,\text{curl}\,\mathrm{B} = \Sigma\mathrm{B}\,\text{curl}\,\mathrm{A} \quad \ldots\ldots \quad (65)$$

through all space, A and B being any vector functions; of this (55) above is a special case. Giving proofs of all the potential properties made use of is out of the question. I entered fully into these matters in former articles in this journal. It is customary in mathematical investigations in electromagnetism to virtually prove this and similar theorems over and over again in the course of working out results, instead of merely quoting them; like proving a proposition in "Euclid" *ab initio*, from the axioms and definitions. It would, however, be very desirable to have special names for the various useful vector theorems connected with the ∇ operator. This is sometimes done by quoting a man's name, and leads to confusion, if two theorems are called, for instance, Laplace's theorem. I think the three fundamental theorems of Slope, Version, and Divergence would be recognisable by these names by anyone acquainted with the theorems, though not previously with these names for them. From them follow a number of others of the greatest utility, of which (65) is an example.

(TO BE CONTINUED.)

A SELENO-DIFFERENTIAL RECORDER.

It is a well-known fact that the weak currents necessarily used in submarine telegraphy, where the points connected by cable are very distant from each other, are capable of working only a limited number of telegraphic instruments. For practical working these instruments consist almost solely of Thomson's reflecting galvanometer and syphon recorder. These, it is almost superfluous to say, are sufficiently sensitive for any purpose, but they possess in themselves certain disadvantages not easily overcome. The reflecting galvanometer, or, as it is almost universally called, the "mirror," is a visual, and not a recording, instrument, and some considerable skill is in many cases required in its manipulation. The syphon recorder, the most perfect instrument we have yet seen for the purposes of long-distance telegraphy, requires to be maintained by powerful and expensive batteries, which feed the mouse mill and the electro-magnets. This expense in regard to the electro-magnets can, as is well known, be dispensed with by employing permanent magnets, but the cost of the energy required to actuate the mouse mill still forms a somewhat large item. Several attempts have been made from time to time by various persons to record the visual signals received on the mirror instrument, in order to obtain a greater degree of accuracy, with a view to increase its efficiency. These attempts have, practically speaking, all resulted in failure.

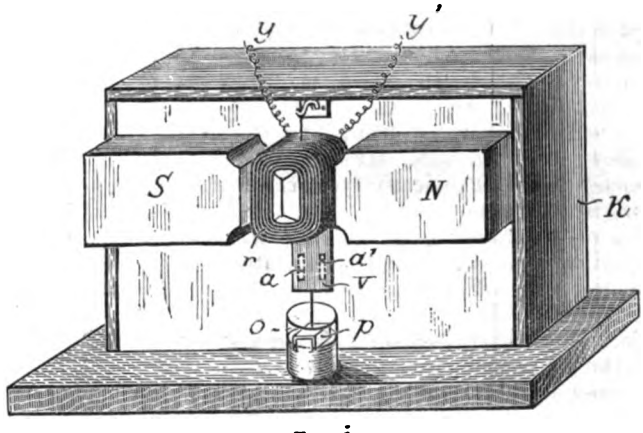

FIG. 1.

Not long ago we had occasion to experiment in this direction, and obtained some good results in regard to greater accuracy by using two pieces of selenium of unequal dimensions in the circuits of two telephones, which gave out sounds upon the resistance of each piece of selenium being altered under the action of the ray of light reflected upon them when the instrument was in operation. The apparatus we are about to describe, which is the invention of Baron Von Taund-Szyll, of Graz, is based in some measure upon the same principle, but possesses the additional advantage of recording the signals as they are received. As regards its practical value we are unable to speak, having no data before us, but if it realises the expectations of its inventor it cannot fail to attract a large share of approbation. The apparatus consists of two main parts, the receiver and releaser, and the relay or simultaneous writing apparatus, constituting the differential recorder.

Fig. 1 is a perspective vertical sectional view of the receiver,

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Fig 2 a plan section of the apparatus, and Figs. 3 and 4 are detailed views. The receiver consists of a tightly-closed box, K, Figs. 1 and 2, containing in an interior compartment a powerful source of light, the rays from which can pass out through two small narrow slits *a* and *a'*, shown also to a larger scale in side view Fig. 3 and plan section Fig. 4. As the light source, an intense glow lamp, *g*, may advantageously be applied, is placed close behind the partitions shown in Fig. 2.

The releaser consists of a small spool frame, *r*, similar to Sir William Thomson's syphon recorder, which is suspended by a silk fibre, and is movable within a very powerful magnetic field N S. The small frame *r* has (as shown in all the figures) a lower prolongation or shutter, *v*, which is of triangular section, and which hangs so in front of the partition of the box K, as to cover exactly the slits *a a'*, and thus when the frame *r* is at rest, prevents the light rays from the glow lamp *g* from passing out through the slits *a a'*. But when the cable current passes through the wires *y y'* into the coils on the spool of the frame *r*, then the frame *r* will be swung lightly to the left or right, according to the polarity of the current, and will thus be brought nearer to one of the magnet poles. As the lower prolongation or shutter *v* partakes of this motion it will open for the slit *a* or *a'*, and let the light rays out of the box K. The light is thus released.

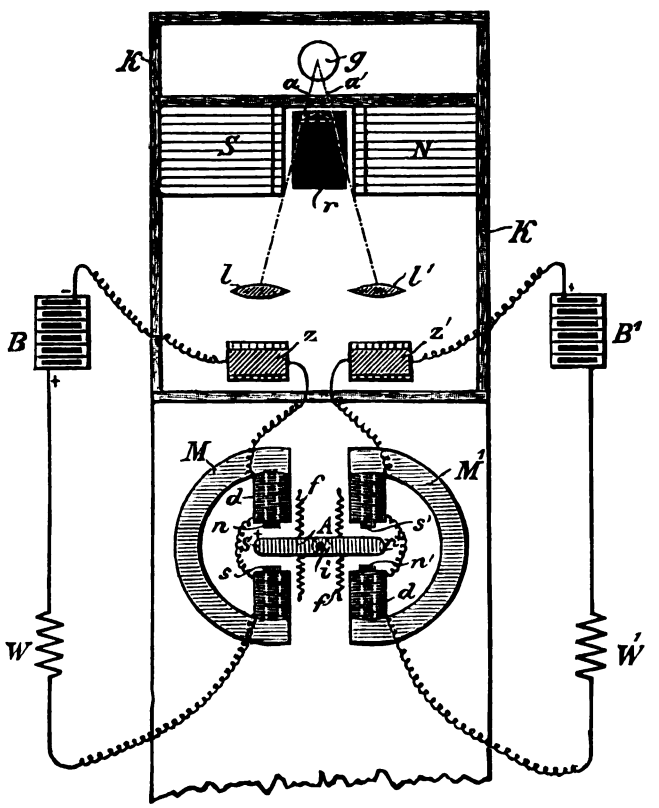

Fig. 2.

In order to regulate the frame *r*, that it does not come into a pendulous motion and so that it may return from a movement into a position of rest, and without going off into an opposite direction, a small plate, *p*, is suspended from the aforesaid shutter *v*, and dips into a small glass, *o*, which is filled with a mixture of glycerine and water to impede its motion.

The arrangement of the differential recorder is as follows:—Within the box K, but in front of the slits *a a'*, in the aforesaid back partition, two powerful convex or collecting lenses, *l* and *l'*, are placed, the foci of which coincide with two selenium cells, *z* and *z'*, so that when one or other of the slits *a a'* is left open by the shutter *v*; the light rays will be concentrated by the collecting lens, and be thrown on the selenium cell on its opposite side. By the light falling on the selenium the resistance which it offers to an electric current flowing round it will, as is well known, be altered. Two polarised horseshoe magnets, M M', carrying soft iron polar cores with powerful coils, *d*, of the finest wire, are so arranged opposite each other that their like poles are crossways, opposite the south pole of one, and just opposite a north pole of the other. Between the poles of the magnets M M' a steel magnet or armature, A, is mounted, to turn on a vertical spindle, *i*, which armature, by means of four helical springs, *f*, is so adjusted that its sides are equidistant from the four pole pieces *n s* and *n' s'* of the two horseshoe magnets M M', whilst the current traverses their coils. It is now to be seen that a difference ever so small in the attraction of the four poles will draw the armature to one side or the other, and both the intensity of such movement and its exactness may be regulated by the helical springs *f*.

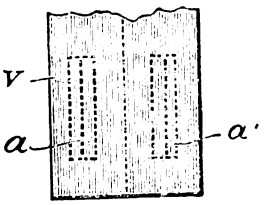

Fig. 3.

The coils of one magnet, M, are by a wire connected with the corresponding selenium cell, *z*, of a local battery, B, and an inserted variable resistance or coil, W; and the coils of the other magnet, M', similarly by a wire with the other selenium cell *z* of another local battery, B', with an inserted variable resistance, W'. The local batteries have several elements. The current from the first-named battery, B, goes to its selenium cell, *z*, then through the coils of the magnet M and the resistance coil W, back to the battery. In like manner a current from the other battery, B', goes to its selenium cell *z'*, then through the coils of the magnet M' and the resistance coil W', back to the battery B'. The two currents are consequently quite separate and distinct from each other.

If, now, the cable currents enter the small frame *r* in such a manner as to turn it towards the south pole, S, then the shutter *v* will open for the light rays to come out through the slit *a'* towards the north pole N, to be collected by the lens *l'* in front of the north pole, and thrown on to the corresponding selenium cell, *z'*. This is all the work which the cable current has to do.

In consequence of the light rays falling on the selenium cell *z'*, this latter will offer quite a different resistance to the current passing through it from the battery B' to that which it offered before the rays fell upon it.

Through this varying resistance, however, the current from the local battery B' is strengthened, but as it flows round the magnet M', the latter will be weakened, and hence, the other magnet M being the stronger, will draw the armature to it, and thus turn it. If a light ray passes out through the other

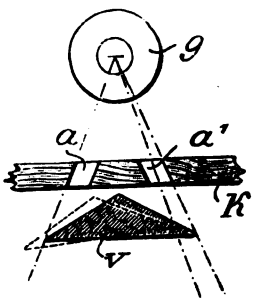

Fig. 4.

slit *a* (by the opposite movement of the small frame *r*) on to the other selenium cell, the same action will take place with regard to the other magnet M, and the armature be turned in the opposite direction. The peculiar arrangement of the magnet poles is in order that the poles should mutually support each other. The north pole *n* of one magnet, M, attracts the south pole *s* of the armature A, and is assisted by the repelling force of the south pole *s* of the same magnet. This assistance by the repelling action paralyses that of the

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north pole n' of the other magnet, M', on the north pole n of the armature. As soon as the cable current ceases, and the small frame r returns to its position of rest, the slits a a' will again be covered by the shutter, and the selenium cell in question assumes its normal resistance, whereby the differential action of the polarised magnets M and M' again ceases, and the armature A returns to its position of rest, or rather the forces which brought it out of the state of rest come into equilibrium again. The inserted resistances W W' have for object to paralyse the resistance variation of the selenium *per se*—that is to say, to render possible a correction relatively thereto, and to equalise the resistances of the two current circuits (the inner and the outer).

The armature is so combined with a writing instrument that it directly or indirectly puts the writing lever into motion.

The whole first part of the apparatus, including the lenses and selenium cells—that is to say the sensitive parts, which may easily get out of order—may be kept air and dust tight under glass, and may be protected against unusual light variation by another covering of opaque material and only the differential recorder need stand in the work room.

SECONDARY GENERATORS.

The following letter has been addressed to Prof. Galileo Ferraris by Dr. J. Hopkinson :—

SIR : Owing to my ignorance of Italian I have been unable to read the copy of your paper, "Secondary Generators of Gaulard and Gibbs," which I received some weeks ago; but an abstracted translation of your paper which is appearing in our journals has made me aware that you have quite misunderstood what method of experiment I adopted in determining the co-efficient of efficiency of these instruments. That you should have thus misunderstood me is not altogether surprising, for I did not attempt to explain my method of experiment, as the purpose of my report was merely to inform the company which consulted me what the capability of their instruments really was. I did not, as I gather you assume, determine the mean difference of potential between two points of the circuit and the mean current in the circuit, and multiply these two together to obtain the work done, for I have for some years — in fact, since I first studied the theory of alternating currents — known that such a method would be erroneous. What I actually did was by a single observation of the electrometer to determine the mean value of the product at each instant of the current and the difference of potential. This is done by a very ingenious modification of the method of M. Joubert proposed by Profs. Ayrton and Perry some years ago. The method is as follows :—Let A B C be three points of a conductor in which an alternating current is passing; let the resistance between A and B be r, and let there be no self-induction or electrostatic capacity between A and B; it is desired to determine the work done by the current. Connect A and B to the two quadrants of the electrometer C to the needle, then if the quadrant electrometer be in perfect adjustment, the force tending to deflect the needle will be proportional to $(A - B)\left(C - \frac{A+B}{2}\right)$, A B C being the potentials at the corresponding points. Now, $C - \frac{A+B}{2}$ is the difference of potential between C and a point, D, midway between A and B, and $\frac{A-B}{r}$ is the current passing in the conductor, hence the force tending to deflect the needle at any instant is proportional to the work being done at that instant between the points D and C. Hence it follows that the deflection of the needle multiplied by the resistance r is a correct measure of the work done in unit time between D and C.

After this explanation I think you will agree with me that the method I adopted was correct, and that I have not made the error you not unnaturally supposed I had made.

Owing to the considerations which you point out, the efficiencies M. Uzel deduces from his experiments are all somewhat lower than those experiments really indicate. My own conclusions, viz. : an efficiency of 79·3 per cent. for the old type of instrument and 86·1 per cent. for the new type are the correct deductions from the observations which I made. My use of the electro-dynamometer in the case in which I used it for verification was also strictly correct, for the self-induction of the portion of the circuit in which I proposed to measure the work done was practically *nil*.

I send herewith a copy of my lecture before the Institution of Civil Engineers, and would ask you to refer to the remarks on p. 11, also a copy of a recent paper of mine on Alternate Currents, in which the subject of secondary generators is touched upon. From these I think you will see that I was hardly likely to make the fundamental error which you have attributed to me.

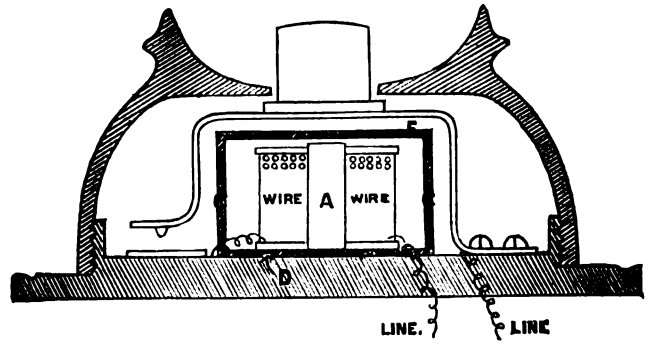
I am sending copies of this letter to the English journals in which abstracts of your paper have appeared.—Yours, &c.,

J. HOPKINSON.

THE MACKENZIE PATENT INDICATOR.

One of the usual complaints against electric bells is that no means exist of knowing whether the bell has rung when the push-button has been pressed.

The Mackenzie indicator, of which a sample and description has been forwarded to us by Messrs. Woodhouse and Rawson, seems to remedy this defect, and to be very simple, and, as far as we can judge merely upon inspection, of an efficient nature.



Its mode of action can be readily seen from the annexed sketch. A is a soft iron core, fixed to an iron base, D, and surrounded by a bobbin of wire, which forms part of the circuit upon which the appliance has to be used. An iron box, C, is placed over this electro-magnet, having the lid E close to the end of the core. Upon the current flowing round the bobbin the core A, and the lid E, being the respective poles of a continuous magnet, become magnetised with opposite polarities, and emit the sound; the make and break action of the bell, however, immediately comes into play, and the core and the lids losing their magnetism again emit a sound which continues to be given out as long as the current is passing.

This is the well-known "Page effect" made use of practically. The action being solely molecular no moving parts are needed, and it is therefore claimed that there is nothing to get out of repair; and being an audible instead of a visual indicator, its use is not restricted to any place where light is required. Its sound is capable of being increased to any desired amount. The apparatus can be adapted to any place where electric bells are used, and can also be made to take the place of a bell itself if required. Being exceedingly small, it can be fitted inside the push itself, the whole forming one complete instrument; or, if preferred, it can be made separately, and adapted to existing arrangements with but trifling cost.

Such an instrument might be applied to numerous other purposes than those set forth above, such for instance as (*a*) telephone circuits between exchange or subscribers; (*b*) between exchanges themselves, showing every time the call bell is rung that the bell is actually ringing, and that therefore the circuit is in proper order; (*c*) on railways in signal boxes this little indicator should be useful, as the pointsman would be certain that the signal transmitted by him to a distant signal box had been received.

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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IS THERE A TELEGRAPH TO MERV?

Last week we hinted at the desirability of one or more submarine cables to the East being in the hands of the naval and military authorities, the exact routes being known only to them. If it is objected that the secret could not be preserved for long, we would remark, first, that if it were preserved long enough to serve the purposes of a war its object would be accomplished. That such secrets can be kept is proved by what is happening now on the northern frontier of Persia and Afghanistan. For over nine months a telegraph line is known to have been in course of construction between Askabad and Merv; yet to this day its progress is uncertain, and even its existence is denied. Partly as illustrating the value of secret telegraphic communication, partly because of the diplomatic importance which attaches to the question whether there is or is not direct communication between St. Petersburg and the Russian military station at Merv, it may be interesting to bring together the evidence at our disposal bearing on this disputed point.

First, however, we should notice a fact, very much to the credit of the military system of Russia, that nobody in this country—at any rate, no Englishman—ventures to speak positively on the subject except at second-hand. Even Mr. Marvin has to trust to the testimony of a Russian newspaper, which to-morrow might announce that its previous information was erroneous. Our military Intelligence Department seems all in the dark, otherwise the Prime Minister would not speak with such uncertainty. The British representative at St. Petersburg is reported as believing there is no telegraph to Merv, and evidently he does not know how near to that place the telegraph line has been extended. The secret has been well kept; the uncertainty surrounding it has already done Russia an immense service, and may do more should the present negotiations be much further prolonged.

That a line of telegraph followed very closely upon the sudden acquisition of Merv is at least highly probable. The submission—or, as some people call it, betrayal—of the Mervis took place early in last year. An army was soon in possession of the place; and it is not the custom to leave a Russian advanced post out of touch with its base. In the June following we announced, on the authority of a telegram from St. Petersburg, that telegraphic communication was "in the course of construction between Merv and Askabad." Evidently the work had been begun—probably from the Askabad end. The railway went only to Kizil Arvat, we believe, but the telegraph had gone ahead of it as far as Askabad. From there to Merv direct the distance is 185 miles; by way of Sarakhs it is only 67 miles further; and, in spite of M. Lessar's suggestions to the contrary, the line could have been completed easily long before now.

On January 10th of the present year we published a statement that authority had been given for the construction of this particular line. Even if the line had only then been begun there has been plenty of reasons in the interval for constructing a military telegraph line over the distance, especially in the face of momentous events which were then impending, the advance of Russian troops far south of Merv, and within the "debateable" territory of Afghanistan, having taken place in the September previous. Besides this, we know that the railroad from the Caspian to Kizil Arvat was pushed on without "authority;" and we may surmise that the enterprising soldiers in charge of the Transcaspian business may not have waited for "authority" to erect a telegraph wire. But a sort of correction to the statement above referred to came almost immediately after it was made public. The *Standard's* correspondent at Teheran telegraphed that the Russians were *already* laying the line from Askabad to Merv, which seemed to imply that the line was in full course of construction, and had not been delayed for lack of authority. Indeed, we are left to fall back on the June telegram as not improbably a true account of the matter. The line was projected then; nothing had happened to delay its completion; many things were happening then and have happened since to expedite it.

On the 11th of the present month we reproduced a telegram from the *Daily Telegraph's* St. Peterburg correspondent stating that Sir Peter Lumsden's despatch *viâ* Meshed relating to the attack on Penj-deh had been delayed by the cutting of the Persian land wire; whereas "the Russian wire is continuous from St. Petersburg to Merv." The correspondent proved to be correct in one particular; none but political reasons of an amiable kind will persuade any practical mind that he was wrong in respect of the other statement. By a singular coincidence it took ten days or thereabouts for both despatches, travelling by different routes, to reach, the one St. Peterburg, the other London. If the correspondent just quoted was correct, it follows that the St. Petersburg telegram from Merv must have been—well, "delayed in transmission."

But that statement does not stand alone. Mr. Marvin's information, obtained from a Russian print, is conclusive. On the 2nd April the Tiflis *Kavkaz* stated the fact that the line from Askabad to Merv "is already constructed and in full working order." The capture of Pul-i-Khisti and Penj-deh took place on 30th March. Only 130 miles separate that locality from Merv, and still less from Sarakhs. And even if we take the most literal view of the *Kavkaz's* language, there can be no doubt that the line to Sarakhs was completed long before the 2nd April. This circumstance completely disposes of M. Lessar's explanations, to which the *Pall Mall Gazette* gives wide publicity. He doubts

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the existence of the line, dwells upon the difficulty of its construction, the scarcity of poles, the transport of wire, of batteries, and so forth. But our announcement of January 10th that the line would take the Sarakhs route instead of going direct to Merv is confirmed by the *Kavkaz*; and as there is a road to Sarakhs from Ak Tèpè, close to the scene of the battle, much shorter than the road to Merv, urgent despatches would probably be forwarded by courier to Sarakhs; and this route would certainly be chosen if, as has been alleged, the telegraph is *not* completed to Merv.

According to the Russian agent in London it will take more than a fortnight for St. Petersburg to exchange communications with General Komaroff. Probably it will; but that it ought to take not nearly half the time is rendered plain by a glance at the map, and the evidence here adduced on the subject. Two telegrams from Meshed, dated 20th April, reached *The Times* and *Standard* offices for publication on the 21st; and Sarakhs is telegraphically as near to St. Petersburg as Meshed is to London. The *Standard's* telegram left Tirpul by courier on 16th. Tirpul is apparently the place where the British Commissioner and his escort have halted as fugitives, just on the eastern frontier of Persia. Four days, therefore, suffice for the camel ride; the distance between there and Meshed is certainly greater than from Pul-i-Khisti to Sarakhs, and little shorter than the road to Merv. Subsequent despatches have traversed the whole distance from Tirpul to London in less than four days.

One other point of some importance we must refer to before dismissing this painful subject. The *Pall Mall Gazette* has persistently asserted that the forward move of the Russians as far south as Zulfikar last September was a counter demonstration against, and justified by, the occupation of Penj-deh by Afghan soldiers last June. Its case indeed rests upon that. The true explanation is not far to seek; but in order to connect the two occurrences it has been repeated time after time that the Afghan occupation in June last was not known in St. Petersburg until the middle of September, where it arrived through the agency of "Dr. Regel at Tashkend." We leave political writers to deal with this astounding allegation as it deserves. All we have to say is that the telegraph brought news of the occupation to this country soon after the event; secondly, that it now only takes ten days (or probably less) to bring news which, it is alleged, took three months to travel last June; and, lastly, that whether or not the line to Sarakhs and Merv had made any progress nine months ago, the line was undoubtedly completed and working as far as Askabad. There were military posts from there to the Merv garrison, less than 200 miles distant; and Penj-deh is only two days' ride south of it. The telegraph would perform its part of the task in a day; yet we are asked to believe that the intelligence took three months in reaching St. Petersburg, and that it went by way of Tashkend. We can only hope that in time of need our military agents will keep the secret of their telegraph engineering operations as well as the Russians have kept theirs.

While the above was being written the *Pall Mall Gazette* announced that its inquiries had "elicited the fact" that the line does not now extend beyond Baba Durmaz, about 70 miles beyond Askabad. No authority is given for this statement, which flatly contradicts Russian testimony given before the question was in dispute. But granting the fact, can this 70 miles of wire make all the difference between three months in the summer of '84 and 10 days in the spring of '85? The reported interruption of the Caspian cable will now, however, render all further denials of the Merv wire quite unnecessary.

THE LATE MR. WILLIAM LADD, F.R.A.S.

We regret to announce the death of Mr. William Ladd, F.R.A.S., at his residence, Burnt Ash Hill, on Thursday, the 16th inst., at the age of 70. Mr. Ladd was well known in scientific and commercial circles for his efforts in the field of electrical research, for during the decade extending from 1860 to 1870 he took a very prominent part in introducing into practical utility the then comparatively obscure science of electricity, which is now deservedly receiving marked attention as the leading science of the day. Nor was his interest in this line confined merely to any particular branch of the science, for we find him at one time in correspondence with Prof. Reis, who may be said to have made the earliest efforts towards recording the sound of the human voice transmitted over long distances. A letter is still extant in which Prof. Reis explains to Mr. Ladd his views upon this question, and the partial success that attended his efforts. Mr. Ladd was well known as the inventor and constructor of some of the largest induction coils and electrical apparatus, manufactured under his supervision at his premises in Beak-street, Regent-street.

In 1867 Mr. Ladd brought forward a dynamo machine, which in many respects showed a marked improvement on the previous dynamos of Siemens, Varley, and Wilde, and whereby many of the then existing difficulties in the way of constructing dynamos for practical and commercial use were removed. Somewhat later, in the year 1878, Mr. Ladd was instrumental in introducing into this country the Wallace-Farmer system of electric lighting from America, where it had met with considerable success. The dynamos and arc lamps employed on this system underwent considerable improvement at Mr. Ladd's hands; and one of the earliest installations of electric lighting afforded to the public was made under Mr. Ladd's supervision on the above system at the Liverpool-street Terminus of the Great Eastern Railway.

Mr. Ladd was from the time of its formation a director of the Anglo-American Brush Electric Light Corporation (Limited), and also of the Electrical Power Storage Company, and he took an active interest in the administration of these companies until almost the day of his death.

CORRESPONDENCE.

INCANDESCENT LAMPS AND THEIR HOLDERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Mr. Scott Snell's letter, in last week's *Electrician*, I think that he has mistaken the purport of my letter of March 14. Sir David Salomons had written in the previous number, complaining, as a consumer, of the frequent changes in the forms of lamps and their holders, a consumer having, according to Sir David's experience, to be continually putting his hand in his pocket, in obedience to some change made at the factory.

My object in the letter which, with your usual courtesy, you were kind enough to find room for, was to show that such frequent changes were by no means necessary, and incidentally to give the results of our own experience. I was not aware at the time to whom the honour of designing the holder was due. A sample was sent to us with a number of others by Mr. Lundberg, and after careful trial we adopted it for general use.

We have recently experienced some little difficulty with it over coaling screens, where the lamp receives a sudden jerk when the coal is tipped over on to the screen. We find that occasionally the loop jerks loose from the hook, a spark passes, often fusing the loop and the spiral hook or both, and the lamp, falling out, is broken. This is the first time we have met with any difficulty with this form of holder, and for this we are now trying Cox-Walker's new holder with the wire loop round the lamp.—Yours, &c., SYDNEY F. WALKER.

195, Severn-road, Cardiff, April 22, 1885.

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ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 479.)

Observe that the contact has not developed any force; it has only, by sweeping away the oxygen from the point of contact, enabled previously existing forces to do work and produce their effect.

The air surrounding the metals in contact is in a state of slight dielectric strain, such as would be produced by two pieces of any one metal of similar size and position, charged so as to differ in potential from each other by a volt.

Zinc and copper plates in contact may therefore be regarded as the plates of a condenser, but they form a peculiar condenser, for they are not really at different potentials; the whole step of potential which throws the air into its state of dielectric strain is located on their bounding surfaces.

Let s and s' be the electrostatic capacity of the zinc and copper respectively; think of them as two independent spheres united by a fine wire; and let x be their common potential; then the zinc has, by the fact of contact, gone up $1{\cdot}8+x$, and the copper has gone down $x-{\cdot}8$; and, since the quantity of electricity which left the one went to the other, it follows that—

$$s(1{\cdot}8-x)=s'(x-{\cdot}8)$$

or

$$x=\frac{1{\cdot}8s+{\cdot}8s'}{s+s'}.$$

There is no necessary relation between s and s' in general, but in the ordinary form of the volta experiment the two plates are of equal size and shape; in which case $s=s'$, and $x=1{\cdot}3$ volt below the potential of the unconstrained air.

All this is wholly unlike a condenser investigation. To treat it as a condenser we must consider the air-surfaces close to the two metals as the plates of the condenser, and we can then speak of its electrostatic capacity S in the ordinary way, and say that it is in the present case charged with the E.M.F. of a volt.

The quantity of electricity on either plate of such a condenser is S $(1{\cdot}8-{\cdot}8)$ or S; hence

$$s(1{\cdot}8-x)=s'(x-{\cdot}8)=S(1{\cdot}8-{\cdot}8).$$

And the general relation between the three S's is like that of two Leyden jars in cascade, viz.,

$$S=\frac{ss'}{s+s'}$$

If the two pieces of metal are circular disks each of radius r, and at a distance z apart, the value of S is of course $\frac{r^2}{4z}$.

In Volta's form of the experiment, two plates are put near each other, connected for an instant, then removed from each other, and the potential of one of them observed. This measures $\frac{S(1{\cdot}8-{\cdot}8)}{s+x}$, where x is the capacity of the electrometer used.

In Pellat's form the charges acquired by contact are neutralised, and the oxygen atoms driven back to their normal distance, by an extraneous E.M.F. carefully adjusted until the plates, after separation, exhibit no charge. This measures $1{\cdot}8-{\cdot}8$ directly.

16. So far I have spoken as if I were sure that (granting the hypothesis) the potential of clean zinc is 1·8 volt below the air; but I am not really sure that this is anything better than an approximation. The fact that no actual combination occurs makes the matter perhaps a little indefinite. If an oxygen atom unites with a zinc atom, one has a right to say distinctly that q has stepped down v; but suppose they are only facing one another, and wishing to combine, are we justified then in asserting that the step v is ready for q to go down, and that it is the same v as before? It almost seems to depend on whether chemical attraction becomes greater as two atoms approach one another, or becomes less.

Suppose, first, it becomes greater, which is the natural hypothesis, then the v calculated from data obtained by permitting the combination to occur will be too large for the step of potential caused by the attraction of metal for oxygen over a standard distance. On the other hand, the differential force urging electricity across a junction of two metals, which is observed in the Volta effect, may be somewhat greater than simply the differences in their pull reckoned at standard distances, because the approach of atoms to the zinc will increase it on this side, and the recession of atoms from the copper will decrease it on that. Hence the Volta effect may perhaps be expected to agree better with calculation than the air/metal potential-difference does, if this latter could be experimentally observed, which it never yet has been.

Next, suppose that chemical attraction becomes less as atoms approach; the step of potential between a metal and air will now be greater than that calculated from chemical data; nevertheless, the Volta effect will be somewhat less than that due to the differences of such steps for two metals, and may thus possibly agree pretty well with calculation.

The agreement or non-agreement of Volta effects with calculation does not therefore quite establish the accuracy of our calculated metal-air contact-forces. But we have no right to assume that even Volta effects will agree with calculation particularly well so long as our data are so slender. They have no chance of accurately agreeing unless the metals used are pure and perfectly clean—a most difficult condition to attain for even a few seconds.

* Reprinted from the *Phil. Mag.* for April.

Before leaving this subject it may be well to point out that, whereas the *calculation* of a Volta effect depends on data obtained by allowing oxygen atoms to approach the metal so as completely and actually to combine, the *experimental determination* by Kohlrausch's and similar methods depends on letting the atoms approach somewhat nearer to one metal and recede somewhat further from another; while the *compensation form* of the experiment employed by Pellat and others depends upon forcing back and restoring the atoms to their original or standard positions. Now, if the views here just expressed have any sense or signification whatever in actual fact, it would be very natural to suppose that the numbers obtained in these three ways might be slightly different. But to specify the direction in which we should expect the differences, if any, to lie would require us to have made up our minds as to the probable variation of chemical attraction with distance. Assuming an inverse variation, the Pellat method should give the least, the Volta or Kohlrausch method the next, and the calculation method the greatest, value for the Volta effect.

But all these ideas complicate the matter somewhat, and they are quite possibly unnecessary. If it be considered that we have no data at present, it may be permitted to work on the simplest hypothesis, viz. that the step

TABLE A.—*Energy of Combination of Metals with Oxygen.*

Metal.	Molecule.	Authority.	Heat of formation.	The same reduced to Volts.
Zinc	Zn,O	Thomsen	85430	1·85
		Joule	77000	1·66
		Andrews	84825	1·84
		Favre and Silbermann	83915	1·82
	Zn,O,H_2O	Thomsen	82600	
Tin	Sn,O	Andrews	67100	1·46
	Sn,O,H_2O	Thomsen	68090	
	$\frac{1}{2}(Sn,O_2)$	Andrews	67680	
	SnO,O	,,	69584	
Lead	Pb,O	Thomsen	50300	1·15
	,,	F. and S.	55350	1·20
	Fe,O	F. and S.	75656	1·64
Iron	Fe,O,H_2O	Thomsen	68280	1·48
	$\frac{1}{3}(Fe_2O_3)$	,,	63730	
	$\frac{1}{4}(Fe_3O_4)$	Andrews	66448	1·44
Nickel	Ni,O,H_2O	Thomsen	60840	1·32
Cobalt	Co,O,H_2O	,,	63400	1·38
Copper	Cu,O	,,	37160	·81
	,,	Andrews	38290	·83
	,,	F. and S.	43770	·95
	Cu_2,O	Thomsen	40810	·89
	Cu,O	Joule	37486	·81
Mercury	Hg,O	Thomsen	30660	·67
	Hg_2,O	,,	42200	·92
Silver	Ag_2,O	,,	5900	·13
	,,	F. and S.	12226	·27
Hydrogen	H_2O, gas	Thomsen	68360	1·49
	H_2O, liquid	,,	78000	1·70
	,,	Dulong, Hess, Grassi, Joule, Berthelot	79600	1·72
Potassium	$2(K,H,O)$	Thomsen	208000	
	$2(K,H,O,aq.)$	,,	232920	
	$K_2,O,aq.$	,,	164560	3·56
	K_2,O	Woods	136000	2·95
Sodium	$2(Na,H,O)$	Thomsen	204060	
	$2(Na,H,O.aq.)$	,,	223620	
	$Na_2,O,aq.$	,,	155260	3·36
	Na_2,O	Woods	151600*	3·28
	,,	Hypothetical	130000	2·82
Calcium	Ca,O	Thomsen	131360	2·85
	Ca,O,H_2O	,,	146400	
	$Ca,O,aq.$	,,	149400	3·24
Barium	Ba,O	,,	130380	2·84
	Ba,O,H_2O	,,	148000	
	$Ba,O,aq.$	,,	158260	
Strontium	Sr,O	,,	130980	2·84
	Sr,O,H_2O	,,	148180	
	$Sr,O,aq.$	,,	157780	3·41
Magnesium	Mg,O	,,	145860	3·16
	Mg,O,H_2O	,,	148960	
Palladium	Pd,O,H_2O	,,	22710	·50
Cadmium	Cd,O,H_2O	,,	65680	1·43
Thallium	Tl_2,O	,,	42240	·92
Manganese	Mn,O,H_2O	,,	94770	2·05
Aluminium	$\frac{1}{2}(Al_2,O_3.3H_2O)$	,,	129600	2·81
Lithium	$Li_2,O,aq.$	,,	166520	3·62
Arsenic	$\frac{1}{2}(As_2,O_3)$	,,	51530	1·12
Bismuth	$\frac{1}{2}(Bi_2,O_3)$	Woods	13200	·29

* This number for sodic oxide agrees with Thomsen's value for the hydrated oxide, whereas for K, Ba, Sr, Ca the oxide is distinctly below the hydrate. By analogy, one would expect to have to subtract some 25,000 from the hydrated oxide $Na_2,O,aq.$, and this gives the 130,000 which I put down as a hypothetical number for Na_2,O.

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v is independent of how nearly chemical action has occurred—that it is the same for atoms straining at one another at their normal distance as for atoms on the verge of combination. And it may be argued in favour of this view that we really have some data, viz., these.

If it were not true, results obtained by Pellat's method could not be expected to agree exactly with those obtained by Kohlrausch's (of which Ayrton and Perry's or Clifton's may be taken as the best examples). Now results obtained by these different methods do agree very fairly well; exact agreement cannot be predicated, for the most trifling circumstances cause large variations in the Volta effect, but no decided disagreement is observable. Again, if it were not true, the Volta effect observed when two metals far apart in the series (*e.g.* zinc and platinum) were employed would be inconsistent with the results obtained by using metals nearer together, say, zinc and tin, or tin and platinum; and if this were so, the metals could not be arranged in the linear series which eighty years ago Volta showed they could be. These arguments throw no light on what may happen *just* before actual combination, still they are encouraging as far as they go.

17. Let us therefore endeavour to suppress further qualms, and calculate a series of metal-air contact-forces from the heats of combustion; remembering that all we have to do, in order to convert heats of combustion per dyad gramme-equivalent into volts, is to divide by $\frac{19320 \times 10^8}{42 \times 10^6}$ that is by 46,000.

But the decision as to what numbers we shall take to represent heats of combustion is a matter of some difficulty, for not only do the numbers obtained by different observers for the same reaction differ, sometimes considerably, but it is not obvious when different oxides are formed which of them we are to consider as most applicable to the case of the Volta experiment. Perhaps one should take the most common or stable oxide; perhaps, seeing that no combination is supposed actually to occur, and, since the metal is, so to speak, in excess, it is most reasonable to take the lowest oxide which the substance will form. It may be that the data are not known for this; it may even be that they have only been obtained for the hydrate instead of for the oxide.

I must therefore do the best I can, and quote several numbers (Table A) wherever there is obvious doubt. I imagine that J. Thomsen's are the most reliable when they are available.

But it must be remembered all through, that since it is only the *tendency* to chemical action which is the cause of the Volta effect, whereas combination heats are obtained by permitting or causing the combination to actually occur, the numbers obtained by calculation are not likely to be quite right; and they may be expected to err on the side of excess, the calculated number being higher than the actual value if directly observed.

Numbers obtained from unsatisfactory oxides and hydrates like those of aluminium, arsenic, and bismuth, are not likely to be useful for our present purpose. I know of no better data yet available however.

It is now easy to write down a Volta series obtained by pure calculation from heats of combustion. We can then see how far it agrees with the results of direct experiment. The principle on which I determine which of the preceding numbers to select is simply to choose Thomsen's when it refers to the simplest oxide, and in other cases to take what one can get. Metals about which there is obvious uncertainty, as for instance sodium, aluminium, bismuth, &c., are omitted.

Calculated Volta Series.

Lithium and Magnesium	3·0	Nickel	1·32
Potassium	2·95	Lead	1·15
Calcium, &c.	2·84	Thallium	·92
Zinc	1·85	Copper	·81
Iron	1·64	Mercury	·67
Tin	1·46	Palladium	·5
Cadmium	1·43	Silver	·13
Cobalt	1·38		

To compare this series with those obtained by experiment we may as well take zinc as the metal of reference, and write down the Volta effect between it and the other metals, first as abstracted from the above table, and then as found by different observers. Strictly, one ought first to subtract Peltier forces from the observed numbers before comparing them with theory; but these forces are too small to make any appreciable difference.

Volta Effects in Air.

Comparison between Theory and Experiment.

Metal pair.	Calculated from heats of oxidation.	Observed by				
		Pellat.		Ayrton and Perry.		Clifton.
		Clean.	Scratched.	Using commercial zinc.	Using amalgamated zinc.	
Zinc :—						
Tin	·39	·25	·35	·28	·46	
Lead	·70 or ·65	·15	·31	·20	·35	
Iron	·21 or ·4	·56	·70	·60	·74	·75
Nickel	·53	·47	·63	...	...	
Copper	1·04 or ·9	·71	·86	·75	·89	·85
Mercury	1·18	...	...	1·06	1·20	1·07
Silver	1·71 or 1·58	·91	1·12	...	...	
Platinum	.....	...	...	·98	1·13	

The alternative calculated number sometimes given is merely to show the kind of variation probable in those cases from uncertainty of data. In each case of agreement the calculated number is a little higher than the observed, as was to be expected. No reason occurs to me for the breakdown and apparent interchange, in the case of lead and iron, but such vague guesses as may occur to every one.

Measurements of the E.M.F. between clean metals plunged into distilled water or weak acid, have been made by Clifton and by Beetz.* I suppose one is justified in calling them

Volta Effects in Water.

Metal pair.	Calculated from heats of oxidation.	Observed by	
		Beetz.	Clifton.
Zinc :—			
Copper	1·0	·98	82 to 92
Silver	1·7	1·23	
Platinum	1·8 or less.	1·52	1·3 (Smee).
Sodium amalgam :—			
Zinc	1·0	·78	
Copper	2·0	1·79	
Silver	2·6	2·05	
Platinum	2·8	2·31	

I do not wish to blink the fact that some of the numbers in the former of the above tables afford a rather poor support to my theory; but it must be remembered, on the other hand, that they are not relative numbers only that we have calculated, but absolute; and the fact that the heats of combustion reduced to volts are numbers of the same order of magnitude as the Volta effects, is of itself a strong confirmation of the belief that chemical strain at the air contacts is the real cause of the apparent contact force at the junction of two metals.

The agreement of the numbers, though not exact, seems to me too close to be the result of accident. One may, I think, claim that the hypothesis whence the calculated numbers are obtained is justified by the figures as far as they go. It is not put forward as a completed theory, but only as a first step to such a theory. I believe it to be a step in the direction of the truth, but it requires working out and elaborating by a scientific chemist.

[TO BE CONTINUED.]

REPORT ON ELECTRIC LIGHTING IN THE CITY.

(CONTINUED FROM PAGE 483.)

I will consider the results obtained under the two heads of Efficiency and Economy.

A. EFFICIENCY.—It is not too much to say, that at the present moment there is not one single thoroughfare in the City of London, or in any of its suburbs, thoroughly and efficiently illuminated. Wimbledon is lighted by oil lamps, having one-inch flat wicks, and burning petroleum oil, of their kind very good when well trimmed and well supervised, but fixed at such distances apart that they cease to become illuminators, and act solely as guides. Carelessness and inattention, however, frequently render them useless and offensive. They are left to burn themselves out, instead of being turned out like gas, and lamps are frequently found burning vigorously in bright sunlight. They are not interfered with by weather so much as gas lights. The light they give when in good order is very steady. Their theoretical illumination is fifteen candles, but their average light is only twelve candles. The gas lamps in the city are supposed to give an illuminating power of fourteen candles, when burning five cubic feet of gas per hour, and they do so when burning steadily and regularly in the laboratory, but when placed in the street lamps the supply of gas becomes irregular through age and dirt in the burner; the flame flickers about through imperfect combustion and through draughts, the lanterns become dim and the glass, therefore, obstructive, and the result is that the average light given is only ten candles instead of fourteen. An electrical glow lamp avoids all the defects of the oil and gas. The light is absolutely steady, and can be regulated and controlled, turned on and off at will. It is independent of weather, but age gradually deteriorates the carbon filament until it breaks. Its average life however is 1,000 hours, and it is replaced with ease and rapidity. We can make oil, gas, or electric lamps to emit any amount of light we desire within reasonable limits, but as we increase the illuminating power of oil and gas we have to increase the sizes of the lanterns and posts until they attain impracticable dimensions. With electricity, however, we have a power of concentration of light that no other illuminant possesses. The same sized lamp can be made to give any light from one to one hundred candles, by simply varying the strength of the current or the size of the filament. It can be fixed anywhere or anyhow. It is not essential to obstruct its light by glass or shades. In fact it is astonishing how thoroughly the glow lamp lends itself to the illumination of our streets, and how immensely superior it is for this purpose to oil or gas. Experiments were made with glow lamps of 10, 20, 30, 50, and 60 candle-power. That which lends itself best to street lighting, and which gave the most favourable results, was Messrs. Woodhouse and Rawson's 50-candle lamp. The most brilliant

* *Ann. der Physik*, x., p. 348 (1880).

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results were given by the Bernstein 60-candle lamp, but its commercial efficiency was inferior. Table A indicates the efficiency of these lamps when incandesced to their nominal candle-power, but if they be incandesced above their normal power, their efficiency increases while their durability diminishes.

TABLE A.

Lamp.	Electromotive force. Volts.	Current Amperes.	Candle power (actual).	Efficiency Watts per Candle.
Swan	51	0·71	11·3	3·2
Swan	49	1·31	19	3·37
Woodhouse and Rawson	55	1·15	20·2	2·35
Woodhouse and Rawson	60	2·33	53	2·4
Bernstein	25	5·25	33	4·0
Bernstein	39·75	6·3	66	3·8
Maxim	80	2·16	50	3·45

No experiments have yet been made to determine the life of lamps at these different states of efficiency, though it is perfectly well known that the higher their efficiency the shorter their career. Since, however, the higher the efficiency of the lamp the less the number of watts per candle consumed, it is evident that there must be some limit for every lamp where the value of its durability just balances the value of its commercial efficiency. It may be a very creditable performance to obtain 2,500 hours' life out of a lamp, and this has been done; but this may have been obtained at an expenditure of power that was commercially ridiculous. The value of the lamp may have been wasted over and over again. The cost of the production of energy is, as a rule, greater than the mere lamp renewal, and the efficiency is of far greater moment than the life. An ordinary 20-candle glow lamp has a guaranteed life of one thousand hours. This, at 4s. per lamp, is equivalent to ·0025d. per candle hour. The price of a watt in London is ·002d. per candle hour, hence a 20-candle lamp costs in power ·006d. per hour; thus it is easily shown that, if the efficiency be reduced from three watts per candle to two watts per candle, the life might be 555 hours, instead of one thousand hours, without any alteration in the cost per candle-power per hour, whereas if we were to maintain the lower efficiency, the value of the lamps would be wasted in energy. It is therefore clearly economical to work at a high efficiency, though it entails a shorter life, and the cheaper the makers turn out their lamps the more easily can this be done. Were it not for the inconvenience of frequent renewals, a short life would be unobjectionable, but as it is, renewals, if frequent, would become a nuisance. The constant renewal of the arc lamp is its great inconvenience. Hence there is some state of efficiency for every glow lamp where these advantages and disadvantages are balanced. The duration and scope of my experiments at Wimbledon did not enable me to test this point. The importance of this question cannot be underrated. The practical efficiency of the arc lights in the City of London is nearly two watts per candle, and they are renewed every eight hours. The practical efficiency of the glow lamps I have used at Wimbledon is a little over two watts per candle, but I never had to renew them at all. If I had incandesced them a little more I might have had to renew them every hundred hours, but I should have obtained the same efficiency from them as from arc lamps. Hence the supposed economy of the arc over the glow lamp disappears. An efficiency of one candle per watt is not unattainable in glow lamps, and when that is reached it will equal an efficient arc lamp in economy.

B. HOW CAN GLOW LAMPS AND THE LIGHT THEY EMIT BE BEST DISTRIBUTED?—I have said that a glow lamp of 50 candle-power lends itself best to street illumination. These lamps were fixed at various distances apart, and at various heights above the ground. They were placed by the sides of the streets and scattered in various ways, but the best effect was produced when they were suspended over the centre of the roadway, 25ft. from the ground. If such lamps were placed in dioptric globes 50ft. apart, the light would be evenly and uniformly distributed. A very great number of reflectors of different patterns were tried, and their effect measured. Diagram No. 3 illustrates some measurements taken. The best effects, as judged by the eye, were obtained by bright nickel-plated iron discs of 18in. diameter. In dealing with the distribution of light from an economical point of view, I must deal partially with estimate and calculation. A horse-power in London can be supplied at one penny per hour for a day of six hours. Taking the net efficiency of the machinery and conductors at 67 per cent. or 500 watts to the horse-power, the cost of a watt hour is ·002d.; although we may hope eventually to obtain in glow lamps one candle-power for each watt expended, we cannot estimate for less than 2·5 watts per candle at present. Hence one candle-power by incandescence costs ·005d. per hour, and 50-candle lamps cost ·25d. per hour; therefore, three 50 candle-power lamps, or 150ft. of street, cost 0·75d. per hour. On the other hand, one candle per watt is easily obtained by arc light, though the average useful light from the Brush lamp is by measurement not more than one candle per 1·9 watt. Let us take it at 1·49 watt per candle, or one actual horse-power per lamp, then each 150ft. of street costs one penny per hour, while when illuminated by glow lamps, it costs only 0·75d. for the same time.

THE COST OF WORKING.—The experiments at Wimbledon were carried on from March 21st to June 21st, 1884. The nature of the experiments involved considerable variation and irregularity in the working, but I was able to obtain eight weeks' continued working of 76 lamps, of 20 candle-power, and to reduce the cost of working to an average of six hours per night, and therefore to so much per lamp per hour. Table B gives the result:—

TABLE B.

EXPENSES OF 76 LIGHTS FOR EIGHT WEEKS.

		£	s.	d.	Per night of 6 hrs.:	s.	d.
Coal	7 h.p. at 4lb. per h.p. per hour at 18s. per ton	3	15	6	1½cwt.	1	4
Wood	2d. per night	0	10	6	.....	0	2
Oil	3½ gallons at 4s. 6d.	0	16	6	Oil and waste, say	0	4½
Waste	8lb.	0	4	0			
Lamps	*76 lamps at 1,000 hours' life at 5s. per lamp.	6	8	0	Lamps, say	2	3½
Ditto	Repairs	0	6	0	Repairs, &c, say	0	1½
Brushes	Brushes at 3 months per set	0	2	0			
Wages	Lampman	9	4	0	Wages	8	8
	Driver	11	12	0			
Interest and depreciation	Interest and depreciation on £500 at 10 per cent.	7	6	0	.....	2	6
	Total	40	4	6	.....	15	5½

* This life is guaranteed by the makers.

This is equal to 0·408d. per lamp per hour. Now, since the same staff could have attended to 400 similar lamps, Table C shows what the cost would have been had that number of lamps been used:—

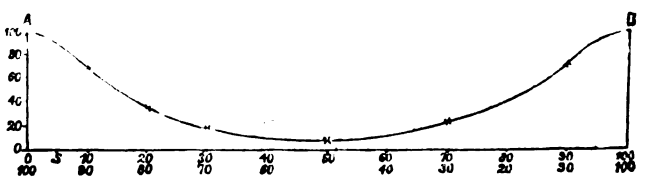
TABLE C.

EXPENSES PER NIGHT OF 76 LIGHTS FOR EIGHT WEEKS.

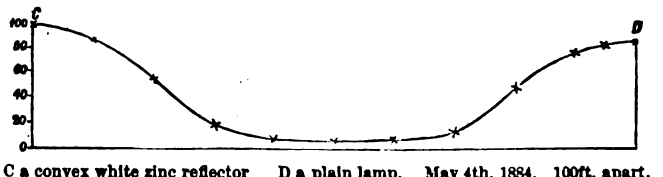
		£	s.	d.
Coal	40 h.p., at 4lb. for 6 hours = 8½cwt.	0	7	8
Wood		0	0	2
Oil	2 pints and waste	0	1	3
Repairs, &c.		0	0	4
Lamps	Renewals, at 1,000 hours' life, at 5s.	0	12	0
Wages		0	8	8
Interest and depreciation	at 10 per cent. on £1,600	0	8	9
	Total	1	18	10

= nearly 0·2d. per lamp per hour.

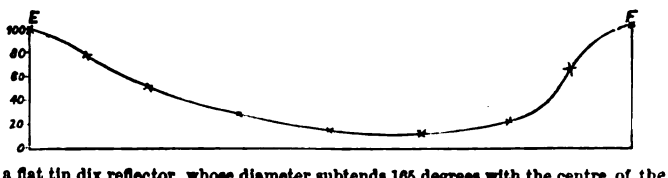
DIAGRAM 3.



A and B two plain lamps. May 21st, 1884. 100ft. apart, 20ft. high.



C a convex white zinc reflector D a plain lamp. May 4th, 1884. 100ft. apart, 16ft. high.



E a flat tin dix reflector, whose diameter subtends 165 degrees with the centre of the lamp. F a convex white zinc reflector. 100ft. apart, 16ft. high.

A Trotter dioptric cone, shade 20ft. high. The red line shows the resultant of two such shades 150ft. apart. Variation 33 % of Maximum.

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The actual cost of 76 lamps was less than ½d. per lamp per hour; the estimated cost of 400 lamps is nearly one-fifth of a penny per hour, the same price as an ordinary gas burner, burning five cubic feet per hour, when gas is 4s. 2d. per thousand cubic feet. This, however, is independent of rent. Rent would probably bring it up to one fathing per lamp per hour. Let us take it at one farthing per lamp of twenty candles per hour. It follows that a 20 candle-power glow lamp can be maintained for the same price as a nominal 14 candle-power gas burner, such as those used in the streets of the City. But in this calculation no allowance has been made for capital, supervision, accident, insurance, &c., items very difficult to allow for, but all of which are contingencies which must be taken into consideration. I prefer to take as my unit 10 candle-power, not only because I experimented with such lamps, but because it is the mean average of the existing street gas lamps, and a very convenient number for glow lamps. Taking all facts into consideration, I think I am fully justified in estimating the total cost of producing 10 candle-power by glow lamps, for six hours per night at not less than ½d. per unit per hour. It is probable that this would be too high if we employed 50-candle lamps, for the charge on renewal and depreciation would be diminished, owing to there being fewer lamps to renew; but I would rather have my estimate too high than err on the wrong side. The result is that when we compare lighting our streets by gas and by electricity, the cost of each at the present price charged for gas is about the same, but the conveniences and advantages of the electric mode are so manifestly superior to the gas, that it is difficult to justify a continuance of the present method. It will perhaps be instructive to record the accidents and failures that occurred during this three months' trial:—1. March 21st—Bearing of dynamo got very hot. No stoppage. 2. March 22nd—Lacing of belt gave way. Three minutes' stoppage. 3. April 1st—Parallel or group gave out, owing to lamp breaking or being broken. Circuit stopped for 39 minutes. No automatic compensation in use at this time. 4. April 7th—Another parallel gave way during experiment, owing to imperfect adjustment. 5. April 29th—Another parallel gave way, owing to a change of dynamo. [N.B.—After this, compensating secondary cells were inserted in each group, and this liability to failure cured.] 6. May 12th—Three lamps went out, probably from stone throwing, but compensating cells prevented any breakdown. 7. June 10th—Coil gave way in dynamo—all lights out. These were all the accidents that took place, and were all due to preventible causes. The last failure would not have interfered with the lighting had there been, as there ought to have been, a spare dynamo, for the defect was observed long before it interfered with the lighting. The arrangements were made, and the experiments conducted by Mr. Albert H. Howard.

(TO BE CONTINUED.)

B.T.K. STORAGE BATTERIES.

The following is the report of Prof. G. Forbes to the Consolidated Electric Company on these batteries:—

"GENTLEMEN: I have spent a long time in experimenting on the B.T.K. Storage Batteries. I am now in a position to state the efficiency and commercial output of the batteries tested, and to judge of the action of the master-cell, and the general working of the cells. For these experiments I used Sir William Thomson's graded galvanometers, and two Ayrton and Perry instruments. I calibrated the galvanometers for measuring current by frequent comparisons with a voltameter, and the galvanometers for measuring differences of potential by passing a known current through a known resistance. It has been very usual to test the efficiency of an accumulator by a single charge and discharge. I do not consider that this is a trustworthy method. I took the mean of five charges and five discharges in succession, and the observations during this time numbered 960. I used 18 cells of the battery in series. The batteries were locked in a room of which I held the key. The experiments for efficiency lasted a fortnight. I invited your *employés* to supply me with the charging current which they preferred to use, and I discharged at the rate which they adopt in practice. I charged in every case until the master-cell acted, and discharged until the E.M.F. had fallen more than would be convenient in practice. On the first day the current was not strong enough, and the master-cell did not act for about 18 hours. The master-cell generally acted well if a proper current was supplied, but it acts earlier or later as the current is stronger or weaker. If the current be properly regulated it acts well. The experiments gave the following data for calculating the practical commercial efficiency of the battery:—

Total in 1st charge.....	10,905·32	
,, 1st discharge		3,779·25
,, 2nd charge	5,195·20	
,, 2nd discharge		3,804·27
,, 3rd charge	5,302·63	
,, 3rd discharge		2,835·48
,, 4th charge	3,997·51	
,, 4th discharge		1,829·63
,, 5th charge	2,632·39	
,, 5th discharge		4,635·64
Total Charge	28,033·056	
Total Discharge		16,884·274

True commercial efficiency 60·23 per cent.

"The efficiency of batteries is sometimes given by using the E.M.F. of the batteries instead of the difference of potential between terminals. This is really of no value, but in this way my experiments give the nett efficiency = 67·69 per cent. Several of the cells were not in perfect order, and lost their E.M.F. entirely; owing to this cause the efficiency given above is not so high as it would have been with better cells. In order to measure the maximum output of these batteries, I charged them fully without the master-cell, and measured the work given out. I thus got a total of 263·2 ampere hours. But in this time the E.M.F. had fallen very low indeed. The practical output was finished in seven hours, by which time the E.M.F. had fallen 18 per cent., and the output was 132·01 ampere hours.

"The weight of the lead plates in a single cell was—

7 negative plates = 27lb. 3¼oz.
8 positive do. = 30lb. 11oz.

Total..... 57lb. 14¼oz.

(N.B.—I use the terms negative and positive as electricians use them).

"Thus we may say that the useful output is 2·3 ampere hours per lb. weight of plates. But this weight includes the supports and terminals of the plates. It must also be remarked that reports are often made of the output of storage batteries in which the weight of active material (the lead salts) is alone included, and the lead support of the plates is omitted; this is misleading. A certain amount of bulging was noticed in some of the plates after a lengthy discharge. This would not occur with these plates when properly used.

"In conclusion, my opinion is that these cells are good, and that their performance would have been better if they had been better treated before being placed in my hands. The inequalities in different cells would then not have appeared, and the injurious consequences would have been avoided. After I had completed the experiments recorded in the above report I was asked, in view of my statement that the cells were not in perfect order, to test another battery of 18 cells by a single charge and discharge under favourable conditions. The results are given below. In the foregoing experiments I had worked the cells under ordinary working conditions, charging them one day and discharging them the next day at a fairly rapid rate. I now undertook to charge them until they gave off gas, and then immediately to commence the discharge at a slow rate, taking observations continuously at intervals of ten to thirty minutes. This involved continuous observation during 26 hours. I have already stated that I do not consider the efficiency as determined by a single charge and discharge to be capable of the great exactitude which I had aimed at in my five charges and five discharges previously. In order, however, to make the result as reliable as possible under the circumstances, I commenced work by charging for 45 minutes, and then discharged for an hour, and noted the E.M.F. I then charged for nine hours at the rate of 22 to 30 amperes, *i.e.*, from 1:40 p.m. to 10:10 p.m. on 16th March, 1885. I then discharged for about 14 hours at the rate of about 13 to 14 amperes. At the end of this time the E.M.F. had fallen down to what it was in my preliminary discharge. The discharge lasted from 11 p.m. March 16th until 1:15 p.m. on March 17th. The charge put in was not the total charge which might have been given had the object been to measure the capacity instead of the efficiency of the accumulators. The E.M.F. fell only 14 per cent. during the period of discharge, so that the batteries still retained a considerable charge; but in practical working the limits of charge and discharge which I used ought not to be exceeded. The result arrived at was that the charge given to the accumulators was 242·18 ampere hours, and the discharge to reduce it to its primitive condition was 193·48 ampere hours, which gives the efficiency in ampere hours at 79·89 %. But this is not the true efficiency, because the E.M.F. and the resistance of the battery must be taken into account. Calculating the results in this way, the true and practical efficiency comes out 69·02 %. I am able to form no reliable opinion on the probable life of these batteries, as it is impossible, without tests lasting over years, to obtain data upon which to form an opinion. I think it right to point out that my method of testing (putting a number of cells in series) is far more severe, and is certain to give less satisfactory results, than if I tested a single cell. But it is the only method which gives a satisfactory idea of their action in practice, as it is usual to employ a number of cells in series."

THE COMMITTEE ON OVERHEAD WIRES.

The Select Committee of the House of Commons for inquiring into the law relating to telephone, telegraph, and other wires resumed its sittings on Thursday, the 16th inst., Mr. G. W. Russell presiding.

The first witness called was Mr. JOHNSON, the chairman of the Commissioners of Sewers of the City of London, who was examined by the Chairman. He said he had had occasion officially to give much attention to the use of wires in the city, and his opinion was that legislation was much needed. Asked whether it was preferable to have underground or overhead wires, he replied that if it were possible to put all the wires underground they believed that would be undoubtedly the best course, but the difficulties were very great, if not insurmountable, chiefly on account of the enormous cost. They also thought that the difference between the action of the telegraph and telephone wires would warrant separate treatment, so that the telephone must be overhead and the telegraph underground.

You speak of the expense of having the wires underground, would it alter the telephone business?—Yes; if the whole of the expense of putting the wires underground were thrown upon the telegraph and telephone

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companies at first, the cost would be too large for them to encounter; still, if the expense were undertaken, we have an impression that the telegraph and telephone companies would be able to pay the necessary amount to cover the original expense.

Upon whom would you charge the cost?—It is not a subject which we have really discussed to any great extent. My own idea is that it should not be out of the rates, but that the rentals charged for the wires should be made to recoup the original expense.

What is your view of the administration of the law upon the subject?—At first I would entrust it to the local authority who had the control of the streets.

You would not be prepared to give an opinion as to what should be the controlling authority in any part of London out of the City?—In the City and elsewhere the staff is existent and the means are at hand for the purpose of exercising any amount of control. Delay would be avoided by utilising these staffs.

A great many witnesses have stated that it would be impossible to carry on the business of the companies if they were subjected to the control of many bodies, and they wanted to be placed under the Board of Works, or one municipal body?—It occurs to me that a difficulty would arise if too much discretion were given; but if the Act of Parliament were to define how the wires were to be carried, either above or below ground, and some definite directions were given, it would not be beyond the scope of any local authority to see that the restrictions were observed.

It has been recommended by many witnesses that all the bye laws affecting these wires should be subject to the control of one of the departments of the Government—the Board of Trade or the Local Government Board?—I should think it extremely necessary.

Sir JAMES HOGG: Who is to pay for the cost of these subways?—My idea is that the capital cost should be provided by some such body as the Loan Commissioners; at any rate, it should not be out of the rates.

Would not the putting of subways all through London be an absurd expense?—I do not advocate it. I believe it to be too large an undertaking; at all events, at present.

As regards the inspection, the different companies would have to pay a certain amount to any body for that work?—Certainly; there was no one body in London of sufficient experience or knowlege of the wants of London to qualify them for taking over the general control of the regulations.

Then, if there is nobody at present existing who can make bye laws, to whom would you give that power—the House of Commons could not undertake it?—I would allow each local body to use its local knowledge for the purpose of making such bye laws as are especially suited to their district. I think it would be quite possible to make a code of bye laws.

So you think that 28 sets of bye laws made by 28 different bodies would be the most convenient tribunal for the Companies to go to?—Yes, for the matters relating to each district. They must accommodate their work to the requirements of the district.

By Mr. GRAY: The gist of your evidence is that you would preserve the regulation by local authorities, while securing by the authority of a confirming body such a conformity of regulations as would be necessary for the discharge of business?—Yes.

Do you think that subways should be introduced into the City?—No. The word "subway," as I understand it, means a long tunnel in which a man can walk, and in which pipes and wires can be laid. The construction of such subways would involve cost of immense magnitude, and I should disapprove of it. I think the system of carrying wires close to the kerb underground, as has been done in the case of the telegraph wires, might be adopted with advantage.

Are you aware that the Post Office wires in the City are as a rule systems of trunk wires, and that the telephone system splits up in order to enable the telegraph wires to be carried to individual places?—If your proposal involves the opening up of numbers of streets for these wires going to individual establishments, how do you view the question as regards the traffic?—The use of gas and water pipes afford some parallel.

But these wires would be laid as occasion might arise at different times?—Of course there is that difficulty.

In continued examination, witness said that the increase in the number of overhead wires was most alarming. There were now ten times as many wires as there were a few years ago, and in squalls some of the posts were so overloaded that they deviated from the upright. In the case of a heavy hail or snowstorm a whole system might be swept away.

The CHAIRMAN: Do you think the lines running by the side of the kerb would be more desirable than the overhead wires?—I think they would be a great improvement.

We have heard that there is a scientific difficulty in the way of carrying telephone wires underground. Do you think the difficulties to that are so great as to be insuperable?—I am afraid that the telephone wires must remain overhead. I would try to relieve the strain by putting the telegraph wires underground.

Lieut.-Colonel HAYWOOD, engineer to the Commissioners of Sewers, was the next witness. In answer to the Chairman, he said that in his official capacity he had seen with alarm the rapid increase in the number of overhead wires in the metropolis, an increase so large that these lines now constituted a public nuisance. A return giving the number of the wires in the City showed that across Moorgate-street there were 320 wires, across Coleman-street, 320; across Leadenhall-street, in a length of 1,414 feet, 240; across Fenchurch-street, in a length of 1,700 feet, 160; and across Queen Victoria-street, in 2,000 feet, eight large cables and 408 wires. At Ludgate-circus you could count 142 wires and two cables. In King-street, leading to the Guildhall, there were six cables and 74 wires in a length of 520ft. Cannon-street had seven cables and 360 wires. In some streets there were from 1,200 to 1,500 wires to the mile, and the mean for the City was about 1,000 to the mile. In many places they seemed to darken the air.

You speak with alarm as to the increase of these wires. Have you, in your own experience, heard of any accidents?—There have been extremely few accidents—I have only heard of two. Of course, at present everything is new, and the atmosphere has scarcely had time to work upon the wires. Further examined, witness said that ordinary wires would probably need extensive repairs in 10 or 12 years. The durability of copper wires was much greater. He had not heard of any accidents from the snowstorm of a few weeks ago.

You are of opinion that danger is to be anticipated?—Of course the risk will increase in proportion to the number of wires and in proportion to the number of persons in the streets. The latter reason increases the element of danger in the City. The night population of the City is very trifling—not more than 50,000 or 60,000. But for ten hours in the day there are about 350,000 people in the City, and the population passing in and out of the City daily is about three-quarters of a million.

To what causes besides deterioration should you look for danger from the wires?—Wind, snow, and fire. A fire may occur in a house supporting the wires.

You are of opinion that the method of carrying the wires underground ought to be adopted?—I think so; I think that the public ought not to be subjected to the risk of accidents, although I am bound to say the risk is not extremely great at the present time. I also think the air ought not to be darkened by these wires. The expense of laying the wires underground must, of course, be very great; but in the interest of the public it must be borne.

But it has been said that the expense would be fatal to the development of the telephone system.—I have no doubt the companies would object to the increased expense, but I doubt whether it would be prohibitory. My own opinion is that there ought to be in all the main streets of the metropolis subways such as the Corporation of London constructed in Holborn, and that in these subways should be placed not only these wires but gas-pipes and water-pipes, the Hydraulic Power Company's pipes, the Electric Lighting Company's pipes (whenever they come into existence, as they will do when the ridiculous Act of Parliament is repealed), the Pneumatic Despatch Company's pipes, the Pneumatic Block Company's pipes, and all other wires and pipes.

Your Chairman summed up in favour of underground wires for telegraphs and overhead wires for telephone purposes. You do not agree with that?—No; I would have them all underground, and have subways large enough for the purpose. I believe that this is the only way of getting rid of the danger I anticipate.

Have you any knowledge of the other schemes which have been suggested for minimising the danger?—Yes; I have heard of one for putting up large candelabras in front of houses, and another for putting up posts along the public way. In the first case there would have to be compensation provided for persons who objected, and the second scheme would be inconvenient as narrowing the footpath.

You have admitted that the plan of making a subway is a costly one. On whom would you propose to throw the expense of construction?—I can scarcely say. Certainly the local authority ought to have the control over them, and the cost must ultimately be borne by the users.

Have you any views as to the proper controlling authority in London?—In my opinion the general control should be placed in the hands of the Board of Trade, and the supervision of the execution of their regulations should be entrusted to the local authorities. The Board of Trade have a control over the gas and water companies, and I see no reason why their jurisdiction should not be extended to the companies owning these wires, though I see very great difficulty in anybody cuntrolling the wires so long as they are carried along the tops of the houses. The best way to guard the public against danger under the present system would be to impose a penalty of from £100 to £500 for every wire that falls, whether anybody is injured or not.—In further examination witness said he thought the work of constructing these subways might be undertaken by the gas companies. At present these companies were compelled, on reaching a certain dividend, to reduce their charges. He thought the reduction might for a time be dispensed with, and the sums thus rendered available should be devoted to subways such as he had mentioned. Of course this would be open to objection as a tax on the users of gas, but somebody must be taxed for it, and it was his experience that there was less objection to indirect than to direct taxation. Several provincial authorities were in the habit of devoting gas and water rates to local improvements.

Mr. GRAY asked whether witness had formed any opinion as to the cost of the subways?—Witness answered that proper subways could hardly be constructed for less than £40,000 a mile. He did not think that the proximity of the respective wires would interfere with their proper working. It would of course be necessary for the wires to emerge at places.

Would not your proposal double the charge to those who use the telephones?—I dare say it would, but I do not think the charge would be prohibitory.

You think the telephone would be equally used at £40 a year as at £20?—Of course there might not be quite as many customers at the higher charge as at the lower.

By Sir J. M'GAREL HOGG: It would be quite practicable to make subways in the crowded thoroughfares of the city of London, if it were decided to face the inconvenience and expense. He was taking into consideration the whole group of wires and pipes. He did not think it would be worth while to go to great expense for these wires alone.

Mr. FOWLER, Vice Deputy Chairman of the Metropolitan Board of Works, said that the attention of the Board had been directed to the possible inconvenience and mischief which might arise from the development of the systems of overhead wires. In view of the attempt of the United Telephone Company to obtain legislation on the subject, he might state that the Board considered it desirable that the telephone companies should be subject to the control of a central licensing authority, and that a record should be kept of every wire erected. It was not the wish of the Board

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to fetter in any way the development of an important commercial undertaking which was now becoming a public necessity, and he fully admitted that everything should be done to encourage its extension. He objected to the proposal to grant to the Companies a right of compulsory attachment, but did not think that compensation should be paid to owners in cases where lines passed over without touching property—that would only be an ordinary case of way leave. He thought the danger from overhead wires had been greatly overrated, and that proper supervision would be sufficient to secure reasonable security from accident. The only difficulties in the way of taking wires underground were the expense and the inconvenience resulting from the opening of public roads; but these objections were so serious that the scheme would be impracticable.

At the conclusion of the evidence of this witness, the Committee adjourned until Monday, the 20th inst.

On Monday the Select Committee of the House of Commons resumed its sitting on the law controlling the telephone, telegraph, and other wires, Mr. G. W. Russell presiding.

Sir ARTHUR HOBHOUSE was the first witness called, and in reply to the chairman he said that he represented St. George's Vestry, and had been requested to give evidence with reference to the proper control of the wires. The vestry had had very little experience of wires, because, while the wires fell, and caused an obstruction, they had no jurisdiction. They had had complaints of wires falling, but no personal injury had resulted. Some of the vestries had desired that the control should be in the vestries themselves. St. George's had never contended for that, but they had desired that inasmuch as the matter was of great public interest and novel, and the law was entirely insufficient to deal with it, that there should be some public authority having the control over the laying and the maintenance of the wires. As to the sort of control to be exercised that was a question of considerable difficulty, and on which there was a great difference of opinion amongst the vestries. The St. George's Vestry could not see their way to ask that the vestries themselves should have a veto upon the establishment of a wire, because wires extended over districts larger than the jurisdiction of the vestries, and consequently conflicting views might arise. On the other hand, St. George's Vestry was strongly of opinion that the details of laying and maintenance of the wires were the proper subjects of strict local control. St. George's Vestry had passed resolutions on the subject as follows:—That it is necessary to create some central authority other than the existing local authority for the purpose of deciding whether power should be given to erect wires in cases where it is proposed to lay wires extending over an area subject to more than one local authority; that such central authority should be either the Metropolitan Board of Works or Board of Trade; that such central authority should have jurisdiction over the erecting of wires from point to point or within certain lines of deviation; and that all questions relating to the mode of erecting such wires and to maintenance and supervision should be left to the decision of the local authority; and further that all questions relating to wires entirely within the area subject to the local authority should be left to the decision of the local authority. To point out the cases in which there was a dividing line between the jurisdiction of the local authority and the central authority, there was the Electric Lighting Act where the whole power was vested in the vestry. The Act said "that notwithstanding anything in the Act the undertakers shall not authorise any line along, over, or across any street without the consent of the local authority." A provisional order might overrule that, and in fact that was done when the vestry remonstrated, and the Board of Trade inserted provisions maintaining the authority which was given by the Electric Lighting Act. There the Board of Trade gave the power to lay the line, and when the line came to the streets then the local power fastened upon it, and nothing could be done without the consent of the vestry.

By Mr. GRAY: The Electric Lighting Act gave to the vestries absolute prohibition.

By Mr. FIRTH: There is no control at present unless there happens to be an annoyance, and then the vestry has jurisdiction. A central authority should have power to make bye laws, but the vestries should have a control of details of maintenance and supervision, supposing the owner of a wire proposed to carry it across the street at a span or angle which the vestry considered too large. The local authority should have jurisdiction in such a case as that.

Would not you lay down that there should be some similarity of general regulations?—That depends upon the subject. You could not make a regulation to have all overhead or all underground wires, because some might be more advantageously placed overhead and others underground; or you could not regulate the span or the strength of the posts, which must depend upon the weight and the thickness; and all these matters were strictly within the jurisdiction of the local authority in each case. The power that should be given to a central authority would be to lay the wires from point to point or within certain lines of deviation. For instance, a company should receive power to place wires from Westminster Bridge to Paddington Station, and the central authority should have the power of saying that they should not be erected in over crowded places. The central authority should not frame bye laws on every subject, for some discretion must be left to the vestries. They should have complete powers as to the ownership of the wires and inspection, and as to the strength of posts, and this would involve some registration, but he would not make it compulsory to register. He had had a wire placed over his own house; but he intended to ask the company to enter into an agreement to remove it whenever he desired. In a company with which he was connected they had demanded 6d. a yard as rent for the wire, and this had been agreed to. That was merely to preserve their legal rights.

By Mr. GRAY: The vestries had no power outside the area of user. At present no damage had been done by the wires in St. George's district.

If the wires were a source of danger to the public would not the local authority then have power?—No. If it could be shown that there was imminent danger the local authority would have power, because it would come under the head of annoyance; but that could not be shown.

By Colonel ALEXANDER: How do you have the right to say anything to a wire going over your house, through the air as it were?—My house gives me the dominion of the moon.

Mr. M'CULLAGH TORRENS: You say that you have a right from the foundations of your house to the moon?—Further than that—from the centre of the earth to the moon; that is my common law right.

By Mr. DICKSON: I do not oppose overhead wires universally.

Is it possible to have a system of underground wires in connection with the development of telephones?—If there were subways that would be all right, but then there are none, or very few. Subways would be very expensive, and it is a simple matter of expense.

Mr. CHARLES MOSSOP, chairman of the Electric Lighting Act Committee of the Chelsea Vestry, said that the vestries and district boards should have authority over the wires. The dual authority of the vestries and the Metropolitan Board was inefficient, and caused great delay. They had passed the following resolution:—"That the authorities to sanction the laying of telephone wires in the metropolis should be the vestries and district boards, and not the Metropolitan Board of Works, and that the dual authority suggested by the Metropolitan Board of Works has already proved inefficient, and that it leads to great difficulties, and causes delay" That resolution was sent to all the vestries and district boards, and up to that morning they had received fifteen replies, and thirteen were in favour of this resolution. The local boards must necessarily know a great deal more than the Metropolitan Board, because the former had several local officers, whereas the Metropolitan Board had only one. If the matter were put into the hands of the Metropolitan Board they would be receiving their information at second hand from the officers of the local boards. The question had practically been settled already, because under the Electric Lighting Act of 1882 it was decided that under no circumstances should the Metropolitan Board be the local authority, and that was carried out. Then the Telephone Bill included such places as Southampton, Manchester, and Leicester, and it would be monstrous to suppose that such places as these would tolerate the appeal to the Metropolitan Board of Works.

Sir JAMES HOGG: There is no idea of Leicester and Manchester being put under the Metropolitan Board. You are raising up an object to knock it down.

Mr. GRAY: It is not so irrelevant, for if there were an appeal in London to the authority and another appeal to a different authority for the country it would be an awkward affair.

The CHAIRMAN: I am bound to say that there would be a different appeal in the case of London and the Provinces.

WITNESS: The reason that I object to the Metropolitan Board is, first of all, because it is contrary to the precedent of the Electric Lighting Act, and, secondly, you get in the arbitrator business. Supposing a dispute arose between Chelsea and St. George's, and the matter were referred to the Metropolitan Board, Chelsea would have only one member to advocate its claims and St. George's would have two; and that would not be an impartial tribunal.

The CHAIRMAN: That is certainly a good point.

By Mr. GRAY: I have drawn up a report to the Vestry as Chairman of the Electric Lighting Committee on the United Telephone Bill, in which I say that, having regard to the value of the telephone to the commercial world and to the power which the Bill provides for the examination and testing of the wires, overhead wires might be used without danger to the public. However the Bill may limit the power of local authorities, it enables them to impose such prohibitive conditions as would either partially or wholly debar the parish from the advantage which telephonic communication affords, as the scale of subscription must of necessity be regulated according to the cost of construction and maintenance. The cost per mile of wires laid underground is £350, whereas overhead wires can be fixed at £10 per mile. With proper supervision these overhead wires could be made safe, and, with periodical testings, they could be efficiently maintained. Under such circumstances local authorities might give their consent to the limited use of overhead wires rather than insist upon the use of underground wires only, at a thirty-fold increase of the outlay, and consequent addition of cost to the user.

Mr. GREENWELL, of the Marylebone Vestry, was the next witness. He said their vestry had submitted a report to the other vestries, and ten of them had agreed to its principle. The chief features of that report were that no existing authority to be created would be better qualified to govern and control of the wires than the existing authorities represented by the western boards, because they formed the only authority under whom all the matters connected with the streets were governed; that the Board of Works should be the court of appeal in case of dispute between the companies and the local authorities, but in case Parliament should not sanction it, then that the alternative should be the Board of Trade. The decision of the court of appeal should be final. Every wire should be registered within six months after the passing of the Act; and to enforce the provisions of the Act there should be penalties.

In reply to Mr. FIRTH, witness said that the reason why they fixed on the Board of Works as the court of appeal was given in their report, viz., because the Metropolitan Board had been the body most identified with the local authorities, and distinctively representative of the people; but should Parliament not accept this proposal then they should like the Board of Trade to be substituted.

Mr. EDWARD BIRD, of the Fulham District Board, next gave evidence. He said they had not much experience of the wires in their district, as they had not many at present. A short time ago a wire broke, but no damage was done. If a resolution making underground wires compulsory

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were passed, the expense would not be great in Fulham. He would place the control of the wires in the District Boards. The central authority should be the Board of Trade. Overhead wires should be tested and inspected by the Board of Trade, and should not be used until they had been so inspected. All the expense should be borne by the companies, as they were trading for profit.

Mr. ADAMS, of the Islington Vestry, said they felt that there was no control over the telephonic wires, and it was of the utmost importance that something should be done. His vestry preferred the Board of Trade to the Metropolitan Board as a court to refer matters in dispute. They had had a man nearly decapitated in Islington by the wires, and up to the present there had been no hurricane to test the stability of the wires.

The committee adjourned until Thursday.

THE CABLE SERVICE TO SOUTH AFRICA.

A meeting of persons in the trade of and connected with South Africa was held on the 17th inst. at the Cannon-street Hotel "To protest against the constant interruptions of the cable service to South Africa, and to take steps for having a duplicate line laid down to meet the exigencies and the growing importance of the trade with South Africa."

Baron ALBERT GRANT, by whom the meeting had been convened, stated that at the wish of two or three firms interested in the trade of South Africa, and also in his own behalf, he had ventured to ask them to attend that meeting with the object set out in the notice convening it. Probably that morning they had received a letter emanating from the Eastern and South African Telegraph Company, and signed by Sir James Anderson, the managing director, who stated that it was not true that there had been a continuous interruption of the cable service. He, however, contended that the reply of Sir James Anderson was no reply at all. He had said that the total number of interruptions spread over five years—though only three and a half years' dates were given—had been 107 days, and the length of each interruption was given. Now, if he (the Chairman) took these figures in a different way, the following were the results:—In 1882 the cable was interrupted twenty days, in 1883 for fifty-one days, in 1884 for twelve days; and already in 1885 the cable had not been in operation for forty days. He maintained that those figures alone showed the correctness of those who viewed the working of the cable as unsatisfactory. He presumed he was addressing a body of gentlemen more or less connected with South Africa, but whether with South Africa or elsewhere the experience was the same, that when once a cable service was established the manner in which all business relations with such distant place and England were conducted was completely changed to that which was the case before the cable was laid. Where commercial firms relied on correspondence they took their measures accordingly, and in the way of remittances, advices, and contracts, the business was conducted by post, and they were prepared for the interval of time necessary to go and come back; but he maintained that when once a cable service was established the public had a right to count upon a continuous service. Such interruptions as those mentioned by Sir James Anderson constituted a most serious inconvenience, and one calling for a remedy. The question was whether they were entitled to enter a protest, which, though a very mild proceeding, injuring no one, had often been found very efficacious. Many of the cables now in operation had been "loaded," as it was termed, at the time they were launched; and but for the "telegraph ring," which was formed many years ago, the telegraph enterprise at this moment in this country would be twice as efficacious as it was, and those who had invested in the undertakings would now be receiving a different rate of return. He did not know whether it was in consequence of that meeting or from pressure on the part of the Government, but Sir James Anderson now admitted that it was necessary to duplicate the line on the section which had been breaking, and he (the Chairman) contended that to that extent it proved that duplication was necessary. With what he regarded as an inferior service they had to pay a very high tariff—10s. a word. If an important colony like the Cape Colony, and all the places served by this cable, could not afford to have a continuous communication, practically free from the risks which he admitted were inseparable to deep sea cables, it was high time that they had such a service. That the Home Government should have been for 24 days without any communication from the Government of the Cape—from January 31 to February—at the time of Sir Charles Warren's expedition in Bechuanaland, and again since the 1st of April (that was, for 16 days) seemed monstrous, especially as the cable in question had been laid, not like other cables, depending on the traffic, but with the stipulation that the Eastern Company should get a *minimum* from the Government for some years. The object he had in asking them to attend that meeting was twofold—first of all, if they agreed with him, to protest against the present system being considered satisfactory, and secondly to say that there should be either a duplicate line along the same coast, or, what he thought better, another or alternate line on the West Coast of Africa, which would accommodate a great many places now without communication, and give them the great advantage of not being dependent entirely on the Eastern line, for they could then send messages by the Brazilian line, joining at Cape de Verde. But, whichever of those two alternatives was to be adopted, he intended asking them to say that a second line was imperatively required; for he doubted very much whether the duplication of the particular section which had been breaking was sufficient. If a second cable were to be laid alongside the present one, he thought that the same cause which had operated on the one would operate on the other. He would therefore propose that a second cable should be laid from the Cape by the West Coast, passing St. Helena, Cape Coast Castle, Sierra Leone, and joining at Cape de Verde, where it would connect with the Brazilian line. The third point was, how was this to be brought about? He did not know whether their meeting there and making a protest and sending it to the Eastern Company would be sufficient; but for his own part he should say that the proper thing to do was to sign a memorial to the Colonial Secretary, pointing out that he, having guaranteed a certain sum as revenue to the existing section of the South African cable, should either call upon the Company to duplicate the line as a necessity for the efficiency of the service, or that, if necessary, the Government should increase their subvention in the public interest, in order to enable the Eastern Company to lay another line, and to be able to do so without the entire risk (in consequence of there not being sufficient traffic) being borne by them. He was sure that no one having any connection with South Africa could be satisfied with the present service; and if that were the opinion of the meeting he would invite them to say so by passing the following resolution:—"That this meeting is of opinion that the service between England and South Africa owing to the frequent interruptions is not satisfactory, and that a repairing ship ought to be provided, so that communications may be kept up by steamer pending repairs, and that representations be made to the Eastern Telegraph Company on the subject."

A gentleman, whose name did not transpire, said that a repairing ship was now engaged in carrying messages.

The CHAIRMAN said that what was meant was that a steamer should be permanently established between the two points to carry messages quite independently of any repairing ship, so that the effect of an interruption of the cable might at all events be minimised.

Mr. BARKER seconded the motion.

Captain MILLS thought there could be no possible objection to the resolution. Everyone connected with South Africa must deplore the interruption to the cable, on account of the immense interests involved. There was a contract between the Cable Company and the Imperial and Colonial Governments which he thought must be regarded in considering the question. When the cable was first proposed by the Imperial Government during the time of the Zulu war, and when it became an absolute necessity, there was an attempt made to lay a cable by the western route; but that proposal fell through, and the contract which he held in his hand was entered into between the Company and the Imperial Government and the Government of the Cape. That contract provided that the cable should be kept open on certain payment of subsidies by the Imperial and Colonial Governments, and that in the event of the cable being interrupted for a period of three months at one time between Durban and Zanzibar, and six months at one time between Aden and Zanzibar, the subsidy should be stopped and not be paid by the Government. As would be seen by the statement of Sir James Anderson that event had never once happened, and the consequence had been that the subsidies had been regularly paid. He had always been of opinion that all cables should run parallel with the lines of steamers, and when this cable was proposed a great number of people at the Cape were of the same opinion, and urged that the cable should go, if possible, down the western route, and run parallel with the main line, in order that all messages might be conveyed at a time of a break in the cable. He was still of that opinion, and would be very glad now to see a cable laid on the western coast. But at the time contrary opinions prevailed, in consequence of the Zulu war and in consequence of Imperial interests, and the cable was laid the other way. Great pressure had been brought on the Company by the Cape Government, and a resolution was passed on the matter by the Legislative Council of the Colony on the 8th of August, 1883. This was forwarded to the Company, who had but one answer—which he supposed would be the answer to any protest at that meeting—which was that their interests and the interests of the public were identical, and that if there were breakages they could not help them, and that they would avoid them if they possibly could. No doubt there was a great deal in this answer; but it appeared to him as taking a practical view of the question that there were two proposals of relief. One was the proposal made by the Company, which was to duplicate that system of the line which had been breaking, which Sir James Anderson had said they were doing, and he had every reason to believe that they had adopted that course. The other way of relief was the one the Chairman proposed, which was a competitive line along the West Coast of Africa.

The CHAIRMAN desired to substitute the word "alternative" for "competitive," as the same company might have it.

Capt. MILLS observed that an alternative line would be a very large undertaking, and he was not at all prepared to say that the Government of Cape Colony, which was now paying, and would have to pay for the next fourteen years, a subsidy of £15,000 a year, would be in a position to subsidise a second line along the West Coast, more especially in view of the fact stated by Sir James Anderson, that the line on the East Coast, which was now a single line, did not pay. A heavy subsidy would under these circumstances be required by any Company who would lay down a cable along the West Coast, and he did not think the Government of Cape Colony was prepared to pay any large subsidy for such a line. In saying that, however, he was speaking without book, and the question had not been considered by the Colonial Government; but he gave his own opinion on the subject of the subsidy. At the present moment he did not see in the contract before them that there was very much to be expected beyond what the Eastern Company was doing. There had been representations made on the subject of the tariff, and on the subject of the interruption of the cable, and he must say that the Company had shown great anxiety in endeavouring to do all that they could to maintain the communication, and when it was broken to put ships on the line, and to carry on the messages.

Mr. SILVERBAUR said he belonged to the Cape of Good Hope. He could well remember, as Captain Mills had just said, when the discussion first arose with regard to laying down the cable that there was a general feeling in favour

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of the western route, on account of the soundings which had been taken and the nature of the sea bottom along the western and eastern coasts. Some difficulty was experienced at the time respecting the subsidy. £15,000 was not very much for the Cape Government to pay; but still the question was in its infancy, and people had to be educated to the advantages of the cable. His eyes had been opened to that, and although at first he had thought that £15,000 was a very heavy sum to pay, as soon as the cable had been at work he in his own business looked upon it not as a luxury but as a necessity of life, and the same thing which had operated on his mind was operating on the minds of others. The colony had been suffering for the last three or four years from excessive droughts, which had had a very prejudicial effect on the general interests of the colony. But this state of things was not going to last for ever. He thought that £15,000 in a few years time would not be considered of great moment considering the enormous advantages which were daily experienced from the cable. The cable, he believed, would never have been laid but for Cetewayo; but he believed that in selecting the eastern coast the selection was made hastily, at a time of great public emergency. It had already, however, been of infinite importance in our political troubles. It had staved off wars and prevented enormous mischiefs by bringing the Colonial Government into direct communication with the Imperial Government in Downing-street. They had dealt with political and commercial interests; but there were also private interests to be considered, and he knew of cases where the cable had become a regular medium of communication and where the greatest inconvenience was experienced whenever a breakage occurred.

Mr. R. J. JENKINS thought after what Captain Mills had said as to the advantages of an alternate route that the question really turned on the raising of the capital. He had some knowledge of cable work, and he could say with every confidence that if the subject were approached now with the manufacturers (of whom there were some half a dozen in this country and some abroad), people would find a very different figure would be asked for the manufacture of a cable. All experience in that line had been bought, and bought very expensively, as the Chairman had said, by the British public. If the matter were taken up in a public manner, and the Imperial and Colonial Governments took up the matter with sufficient spirit, there was public spirit here enough to provide an alternative communication. He had no doubt that the Eastern Company and Sir James Anderson were perfectly honest in saying that the interests of the Company and the public were one. Up to a point they were, but there was a point where the union of interests would cease. Sir James Anderson had stated that the line did not pay; but how could it be expected when it was a considerable time not working? He was satisfied that an alternate route was one that should commend itself rather than duplication, because he believed that duplication would come as a matter of fact.

The CHAIRMAN, in reply, said with regard to the resolution, it was simply limited to a protest as to the way the cable had been working. The question of the route would be the subject of the second resolution. He then put the motion, which was carried, and said that it would be communicated to Sir James Anderson. In respect of the second resolution he observed that it was a declaration that a second cable was necessary, and that it should be laid down, in the opinion of the meeting, *vid* the West Coast. When he had used the word "competitive," he had meant an alternative line. He was delighted that Captain Mills was of his opinion. As to the question of subsidy, he did not think any cause was advanced by want of candour, and his own impression was that without a subvention a line along the West Coast could not pay, and consequently he would not harbour himself under the doubt which Captain Mills had expressed as to whether it would or would not pay, but say at once that it would not pay, and that therefore a subvention was necessary. With great submission, however, to Captain Mills's knowledge of the Cape Government, and with great deference to the opinion expressed by that gentleman, he would venture rather to think with Mr. Silverbauer that if it were a question not of £15,000 but of £50,000, so that the Cape Government and the dependencies could have the proposed additional communication, he thought there would not be any difficulty in getting it, and he believed that the Germans, in view of their new colony, would assist. He regarded the necessity of cable communication now as being as great a necessity as gas or any other daily requirement. It was an absolute necessity, because once they had laid out their arrangements for communication the mere cessation of a week or ten days caused a complete break in the communications. The duplication of the cable along the East Coast was a very proper precaution, but it was not an absolute guarantee, and that was what they wanted as far as possible—an absolute guarantee that they would never get up any morning and find communication 7,000 miles away absolutely stopped for an indefinite period. Therefore, he held, they must go to the West Coast. The question, however, was how far they should make that statement in the City of London without endeavouring to do something practical. His impression was that with the trade on the West Coast, with the subvention which could be obtained from the Imperial Government, and, with great respect to Captain Mills's opinion, from the Cape Colony, and possibly from some of the interior Governments, there would be no difficulty in the matter. As Mr. Jenkins had pointed out now, when cables were at such a very low price, was a favourable opportunity for laying a new cable, which, with a moderate traffic and a subvention, ought to give a moderate return with a very low tariff. He therefore commended the next resolution to their attention. It was as follows:—"That the constant breakages of the cable on the East Coast of Africa involve great interruptions, which are prejudicial to the mercantile community having relations with South Africa, and demand a remedy; and this meeting is of opinion that a second line, *vid* the West Coast of Africa, is imperatively required."

Mr. JENKINS seconded the motion.

Captain MILLS said he had to leave the meeting to fill another engagement, but before going, he desired to say that, in alluding to a subsidy from the Cape Government, he had merely expressed his own opinion, taking care particularly also to mention that he had no instructions from the Government.

The CHAIRMAN put the motion, which was carried. The third resolution would be taking, he said, a practical step towards carrying out the resolution just passed. It was as follows:—"That a memorial embodying the views of this meeting be presented to the Right Honourable the Earl of Derby, Secretary of State for the Colonies, such memorial to be signed by the representatives of the firms interested in the West and East Coasts of South Africa; and those present pledge themselves to use their influence to obtain the end desired."

This resolution was also carried.

The CHAIRMAN afterwards read the memorial, one clause of which was as follows:—"We are of opinion that the great interests represented in South Africa demand a second cable; and, seeing that the British merchants on the West Coast have no means of cable communication, this meeting is of opinion that a second line should be laid down to communicate by the way of the West Coast either from the Cape to Lisbon or to join the Brazilian line at Cape Verde, or such other station as may be found most convenient." In signing this memorial, continued the Chairman, they were committing themselves to nothing beyond putting in writing the opinions they had expressed in the resolutions which they had passed.

A vote of thanks to the Chairman brought the proceedings to a close.

COMPANIES' MEETINGS & REPORTS.

Reuter's Telegram Company (Limited).

The twenty-first ordinary general meeting of the shareholders of this Company was held at the Company's offices, 24, Old Jewry, on Wednesday last, Colonel James Holland presiding.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: As described in our report in the second paragraph, the falling off in the receipts and the net profits as compared with last year is entirely owing to the military operations in China, Egypt, and the Soudan, and especially the latter, for these districts being beyond the course of our regular correspondents we have been compelled to employ special correspondents, and in a service like that in the Soudan and in Egypt it will strike you naturally that it is a service which requires high payment. Great risks are run, and as an evidence of that I may mention that one of our correspondents perished and another was very severely wounded. We have been greatly indebted to the gentlemen who have been and still are our correspondents in those districts for the zeal and the highly satisfactory manner in which they have performed their arduous and perilous duties. But those services, although they tend to keep up our reputation, which is a matter of the first importance to us as a Company formed for the procuring and dissemination of important news, has proved, unfortunately, as might have been expected, anything but beneficial to the shareholders—that is to say, the expenses have increased to a greater extent than the receipts. If you turn to the balance-sheet you will find that the receipts have been £3,700 more than they were last year, which shows at any rate that the business is not falling off. But, on the other hand, the cost of procuring the intelligence has increased by just under £6,000. It will be, therefore, a serious and anxious duty for us as the engagements now standing with the press fall in—as they expire—to endeavour with such fresh agreements as will satisfy the shareholders that a very moderate interest that we look for upon our capital should be made in the future. It is evident that with wars constantly on the horizon expenses must increase beyond the receipts, unless those receipts are augmented, and the outlook is not at all a reassuring one at the present time. Turning to the balance-sheet, there is very little beyond the fact which I have mentioned of increased receipts and increased expenses to note. The liabilities and debtors' accounts are mere current accounts that are settled at the end of every month, and there is nothing whatever to say about them except that the liabilities which existed on the 1st of January no longer exist, and it is so far satisfactory that we may say that we have no bad debts. The current expenses have increased in sympathy with the general expenses of telegrams and agencies. Having increased work to do we have had an increased staff to maintain at home, and there is an item also of about £600, which is not likely to occur again, in increasing the accommodation in the present building. There is really nothing further to say, except to express a hope that when we meet this time next year, as I trust we all may, we shall find that, although the war expenses may still continue, yet that those who benefit by our exertions will be able to show a more complete appreciation of the benefits they receive from us than they have done in the past. With these remarks I have nothing more to do than to propose "That the report and balance-sheet now presented be received and adopted, and entered on the minutes."

Admiral the Right Hon. Sir JOHN HAY, M.P., seconded the motion.

The CHAIRMAN invited discussion, but no one rising to address the meeting, he put the resolution, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. J. S. STOPFORD, Baron de Reuter was re-elected to his seat at the Board.

The auditors, Messrs. Quilter, Ball, and Company, were afterwards re-elected.

Mr. LOVEDAY then proposed a vote of thanks to the Chairman and Directors, the Secretary and staff, observing that he did not think there

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could be a more powerful evidence of the confidence of the shareholders than the paucity of their attendance at that meeting.

The motion having been put and carried, the CHAIRMAN briefly acknowleged the vote, and the proceedings terminated.

The Eastern Extension, Australasia, and China Telegraph Company (Limited).

Report of the Directors for the six months ended 31st December, 1884, to be presented to the shareholders at the twenty-third ordinary general meeting, to be held at the City Terminus Hotel, Cannon-street, on Wednesday, the 29th inst., at 2 o'clock.

The gross receipts, inclusive of Government subsidies, have amounted during that period to £248,087 19s. 5d., against £231,056 1s. 4d. for the corresponding half year of 1883, showing an increase of £17,031 18s. 1d. The working and other expenses, including the abnormally heavy item of £33,746 10s. 1d. for cost of repairs and renewals of cables and expenses of ships, absorb £79,496 9s. 1d. against £69,862 0s. 2d. for the corresponding half year of 1883, leaving a balance of £168,591 10s. 4d. From this is deducted £2,767 13s. 5d. for income tax, and £41,595 for interest on debentures and contributions to sinking funds, leaving £124,228 16s. 11d. as the net profit for the half year, which, with £17,147 18s. 1d. brought forward from the previous half year, leaves an available balance of £141,376 15s. Against this the Directors have charged £20,000 on account of the partial renewal of the Singapore-Saigon and Penang-Rangoon cables. One quarterly interim dividend of 1½ per cent., amounting to £31,250, has been paid for the half year, and it is now proposed to distribute another of like amount, together with a bonus of 2s. per share, payable on the 30th instant, making with the interim dividends and bonus paid for the first half year a total distribution of 7 per cent. for the year 1884. The balance of £33,876 15s. has been carried to the general reserve fund, which now stands at £510,649 11s. 9d. The investments on account of this fund now include the securities shown in former accounts as standing in the names of the trustees of the 5 per cent. Australian subsidy debentures, the same having been sold to the Company to provide funds to meet the bonds drawn for payment on the 1st July last. In pursuance of the conditions upon which the issue was made, 433 of the Company's 5 per cent. debentures of 1880 were drawn by lot on the 18th instant for payment at par on the 1st May next. A new cable steamer, "Magneta," built for the Company by Messrs. R. Napier and Sons, was despatched on the 8th ultimo to Singapore to replace the ss. "Agnes," which had been ordered home to be overhauled with a view to the repairs reported to be necessary. No tidings of the ship's arrival at Gibraltar having been received up to the present time, the Directors are reluctantly compelled to infer that unhappily she has been lost with all hands. The ship was fully insured. The policy of strengthening the weak portions of the Company's system has been continued during the half year by the renewal with brass-ribboned cable of 285 nautical miles of the Singapore-Saigon Section and 100 nautical miles of the Penang-Rangoon Section. Most of the old cable will, it is anticipated, be picked up and brought into the spare stock of cable at Singapore during the current half year, when the cost of the operation will be shown in the accounts. The cable when re-served will be available for further renewals or extensions. The principal cable interruptions during the half year have occurred on the Penang-Madras and Java-Australian (original) Sections. The former took place on the 13th June, during the height of the south-west monsoon, but was successfully repaired during a lull on the 14th July. Unfortunately, however, the large expenditure of cable shown in Abstract C was principally incurred during this repair in consequence of a return of bad weather immediately after restoration of the communication preventing the recovery of the old cable, which, however, may be picked up when a favourable opportunity offers. The cable between Victoria and Tasmania was also interrupted in July, and owing to the unusually severe weather that prevailed at the time, was not repaired until the end of September. To prevent as far as possible a recurrence of the inconvenience to the Colonies and loss to the Company thus occasioned, the Directors have determined to duplicate this section (176 knots in length) from its stock of spare cable at Singapore. All the Company's cables are now in good working order. During the past half year the land line belonging to the South Australian Government between Port Darwin and Adelaide has continued to work well. In accordance with the Articles of Association, Charles William Earle, Esq., and Sir Thomas Fairbairn, Bart., retire by rotation, and offer themselves for re-election. The retiring auditors, Mr. Henry Dever and Messrs. Quilter, Ball, and Co. offer themselves for re-election.

The Oriental Telephone Company (Limited).

Report of the Directors for the year ended 31st December, 1884, to be presented to the shareholders at the Fifth Ordinary General Meeting at the City Terminus Hotel, Cannon-street, on the 28th inst., at one o'clock :—

The profit and loss account, so far as the year's operations are concerned, results in a credit of £3,242 19s. 9d., after including the dividends accrued on shares held in the subsidiary companies. It has been deemed advisable to charge this account with the full liabilities incurred in respect of guarantees to the Bombay and Bengal Companies, and the amount of £9,082 6s. 7d., now appearing to debit, represents the guarantees to 31st December last. The foregoing sum embraces, in the case of the Bombay Company, a period of 18 months from the 1st July, 1883, and in the case of the Bengal Company of 19 months, from 1st June of the same year. A further important item charged to this account is the difference between the nominal market value at the end of the year of the "A" shares held in the Bengal Telephone Company, and the price at which they were valued in the balance sheet for 1883. Against these sums debited as above, the following items have been transferred from the balance sheet of last year to the credit of profit and loss account :—£7,000 entered as a reserve fund, £8,426 0s. 5d. profit on sale of the Bengal Exchange, and a further sum of £1,000, being one-half of the amount, reserved last year in respect of estimated depreciation of the Egyptian Indemnity Award. The indemnity award amounts to 200,000 francs, which will, it is hoped, be received very shortly, and so strengthen the available funds of the Company. The balance remaining at credit of profit and loss is £3,945 1s. 1d., which it is proposed to carry forward to meet current guarantees and possible further depreciation of assets. No new exchanges were opened in the year under review, but one is in course of construction at Moulmein, to which considerable support has been promised, and it is anticipated a small income will be derived therefrom during the current year. The opposition which has existed in Calcutta has been removed. This, we trust, will greatly benefit the Bengal Company. There has been a fair increase in the number of subscribers, to both that and the Bombay Company's exchanges, during the year. The Telephone Company of Egypt has added ninety to its number of subscribers, and the shares held in that Company have been taken into account at the same valuation as last year. From Shanghai the accounts received from the agent are very promising in spite of the unsettled state of China. The books of the China and Japan Company have not yet been made up, the final accounts not having been received. As the shareholders have so recently had placed before them the report of the committee of investigation, the Directors do not think it necessary to make any further statement regarding the affairs of the Company. The call of one shilling per share made payable on the 10th ult. has been received to the extent of £9,600, leaving £1,400 still due. The loan of £5,000 from the bankers has been paid off. The Hon. G. G. Hubbard, Mr. T. A. Edison, and Mr. P. Carnegy, C.I.E., retire from the direction. Messrs. Deloitte, Dever, Griffiths and Co., the auditors of the Company, retire, but offer themselves for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. APRIL 22.		BUSINESS DONE WEEK ENDING APRIL 22. Highest.		Lowest.	
Anglo-American	27½,	28½	.....	28	.....	27½ x.d.
Do. Preferred	48½,	49½	.....	49¾	.....	49 x.d.
Do. Deferred	7,	7½	.....	7½	.....	6½
Brazilian Submarine	10¾,	11	.....	11	.....	10¾
Cuba	10½,	11	.....	—	.....	—
Do. Preference	17,	18	.....	—	.....	—
Direct Spanish	1½,	2	.....	—	.....	—
Do. Preference	9½,	10½	.....	9¾	.....	—
Direct United States Cable	9,	9½	.....	9½	.....	—
Eastern Telegraph	11½,	11⅝	.....	11½	.....	11½ x.d.
Do. 6 per Cent. Preference	13½,	13¾	.....	—	.....	—
Do. 5 per Cent. Debentures, 1899	105,	108	.....	—	.....	—
Eastern Extension	12½,	12¾	.....	12½	.....	12¾
German Union	9½,	9¾	.....	—	.....	—
Globe Telegraph and Trust	6¾,	6⅞	.....	6⅞	.....	6½
Do. Preference	12⅜,	12⅝	.....	12⅝	.....	12 7-16
Great Northern	13¾,	14¼	.....	14¼	.....	13¾
Indo-European	29½,	30½	.....	—	.....	—
Reuter's	7½,	8	.....	—	.....	—
Submarine	175,	185	.....	181	.....	—
West India and Panama	⅝,	¾	.....	—	.....	—
Do. 1st Preference	7½,	7¾	.....	—	.....	—
Western Brazilian	5¾,	5¼	.....	5¼	.....	5¼
Western Union 7 per Cent. 1st Mortgage	120,	125	.....	—	.....	—
Do. 6 per Cent. Sterling Bonds	100,	103	.....	—	.....	—

TELEPHONES.

Consolid. Telephone and Maintenance	7-16	9-16	.....	½	.....	—
Oriental	⅛,	¼	.....	—	.....	—
United Telephone	10,	10½	.....	10¾	.....	10½

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1⅝,	1⅞	.....	—	.....	—
Do. (fully paid)	2⅞,	3¼	.....	3⅜	.....	—
Hammond Light (£3 15s. paid)	¼,	½	.....	—	.....	—
Swan	—	—	.....	—	.....	—
Maxim-Weston	⅛,	¼	.....	3-16	.....	—

MISCELLANEOUS.

Telegraph Construction	83,	84	.....	83½	.....	—
India Rubber, Gutta Percha, and Telegraph Works	21,	22	.....	22	.....	21½

TRAFFIC RECEIPTS FOR MARCH, 1885.

COMPANIES.	March, 1885.	March, 1884.	Increase.	Decrease.
Brazilian Submarine	2,932	—	—	—
Cuba Submarine	3,500	3,296	204	—
Direct Spanish Telegraph	1,455	1,764	—	309
Eastern Extension	46,193	41,351	4,842	—
Eastern Telegraph	68,296	67,285	1,011	—
Great Northern	23,200	—	—	—
West Coast of America	4,290	—	—	—
Western and Brazilian	2,394	—	—	—

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NOTES.

THE SION COLLEGE.—It is proposed to light the new Sion College by electricity.

THE TELEGRAPH TO MERV.—The *Daily News* says:—"The telegraph line to Askabad and Merv is advancing!"

THE SUBMARINE TELEGRAPH CABLES BILL.—This Bill passed through its second reading on Monday night.

ELECTRICITY AND SUBMARINE MINES.—Experiments are about to be made at St. Petersburg with submarine electric lamps.

THE CABLE IN THE CASPIAN SEA.—A telegram from Vienna announces that this cable was cut, on Monday last, by some fishermen.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 24th April amounted to £3,151.

SMART.—The result of the Oxford and Cambridge boat race was received in the office of the New York *Telegram* exactly five seconds after the finish.

NEW CABLE.—The new cable between the Isle of Man and Cumberland has been successfully laid, and telegraphic communication was resumed on Saturday evening.

OVERHEAD WIRES.—A letter, asking the Southend Local Board to petition Parliament against the United Telephone Company Bill, has been referred to the Parliamentary Committee.

THE STANDARD OHM.—We notice in the advertisement columns of a contemporary that a few of these are to be had at 2s. 6d. each. See into what disrepute the unfortunate unit is falling!

THE HONG KONG CABLE.—The Colonial Government has at last recommended the furnishing of the cable and torpedo boats which have been pressed for in *The Times* for some months past.

NEW TELEGRAPH COMPANY.—A company has been organised in Topeka, Kansas, for the immediate construction of a new line of telegraph from Kansas City to California, to be known as the Western Telegraph Company.

THE EASTERN TELEGRAPH COMPANY.—This company announce the payment, by interest warrant, on the 1st May proximo, of interest for the half year ending 30th April on their Four per Cent. Mortgage Debenture Stock.

THE ELECTRIC LIGHT IN RUSSIA.—That the workmen employed by the Russian Steam Navigation Company may work at night, electric light plant of the value of £3,000 has been provided for the illumination of the yards.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ending 24th April were £2,515, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

OPENING OF NEW TELEGRAPH STATIONS IN CHINA.—The Eastern Telegraph Company notifies the opening of three new telegraph stations in China, one on the island of Hainan, called Kiungchow or Hainan, and the others at Liemchow and Neuchang.

THE TELEPHONE WANTED AT BLACKBURN.—Tenders are invited for the erection and maintenance of about 19 miles of telephonic wire, together with the apparatus for working it, at Blackburn. Full particulars will be found in our advertisement columns.

THE ELECTRIC LIGHT ON WARSHIPS.—Messrs. R. E. Crompton and Co. have secured orders for lighting five of Her Majesty's ships. We are informed that this company have orders on their books for dynamos to give a total output of nearly one million watts.

CHEAP TELEPHONES.—On reference to our advertisement columns it will be seen that the Signal Engineering Company are supplying improved telephone receivers, in ebonite cases, at a price which will place these very useful instruments within the reach of everyone.

THE "MAGNETA."—Several bodies have been washed ashore on the Portuguese coast; but up to the time of going to press none have been recognised as belonging to the crew of the missing ship. Instructions have been sent to spare no effort to identify any bodies thus washed ashore.

THE DIRECT UNITED STATES CABLE COMPANY.—The directors of this company have resolved upon the payment of an interim dividend of 3s. per share, being at the rate of 3 per cent. per annum for the quarter ending 31st March, such dividend to be payable on and after 16th inst.

THE ELECTRIC LIGHT AT THE HOUSE OF COMMONS.—The success which has attended the introduction of the electric light in other parts of the House of Commons buildings has induced the First Commissioner of Works to extend this system of illumination to the members' tea room.

THE SOUDAN TELEGRAPH LINE.—On Tuesday morning a party of Hadendowas, probably assisted by some Egyptian convicts who had escaped to Osman Digna, cut the telegraph wires, pulled down several of the poles, and undermined the metals on the railway in several places between Handoub and Suakin.

BATHING IN LIGHTNING.—The *New York Mail* says it is hard to conceive a more risky thing, for example, than some of the electric baths, where the visitor, being shut up in a pen, is entirely at the mercy of an attendant, who may turn on enough electricity to send him to death before he is aware of it.

IMPROVED WHEATSTONE TRANSMITTERS.—The Post Office are now issuing a new form of automatic transmitter capable of running at a speed representing 400 words per minute, 10ft. of paper passing through the instrument in 7½ seconds. The top speed of the old form of transmitter was 200 words a minute.

CHARING-CROSS AND WATERLOO ELECTRIC RAILWAY.—The Bill for extending the Charing-cross and Waterloo Electric Railway from Northumberland-avenue to Cockspur-street has been withdrawn. The Bill was one of a group set down for hearing before Mr. Hardcastle's committee of the House of Commons on Monday.

TELEGRAMS FOR EAST AFRICA.—The Eastern and South African Telegraph Company notifies that the steamer specially engaged to carry telegrams will leave Zanzibar early on Saturday for Mozambique. Telegrams for South Africa to go by this vessel should be sent from London not later than eight o'clock on Friday evening.

THE TELEGRAPH IN CHINA.—The war between the French and the Chinese has, it is said, had the effect of inducing the authorities of the Chinese Empire to extend their telegraph system. The principal towns on the frontier of Yunnam have been connected to Canton by improvised lines, constructed in many cases through dense forests.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY.—At a meeting of the directors of this company held on 29th April, it was decided to place £8,000 to reserve, and to recommend to the shareholders at the approaching meeting

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that a dividend of 6s. per share be declared on account of arrears of dividend on the first preference shares.

OVERHEAD WIRES IN AMERICA.—A discussion is going on at Harrisburg, Pa., on a Bill to place electric wires underground. Representatives of the Western Union and Pennsylvania Electric Light Company have been heard against the Bill. The legislative committee in charge of the measure has decided to limit its operations to cities of the first and second class, which are Philadelphia and Pittsburg.

THE ELECTRIC LIGHT IN CANADA.—We are informed that Messrs. Francis and Co., of the Eagle Telegraph Works, Hatton-garden, E.C., have obtained a contract for the complete installation of electric lighting throughout the New Congress Hotel and avenue at Toronto, together with electric bells and indicators to and from each apartment of the several buildings, and direct telephonic communication between the hotel and the Dominion telegraph stations.

THE ELECTRIC LIGHT IN NEW ORLEANS.—New Orleans has been for a good while debating the lighting of the suburban districts. Finally an ordinance was passed by the City Council, and signed by the Mayor, awarding the contract for tower lights to the Louisiana Electric Light Company. On 17th March the Council decided that 34 tower lights should be furnished at an annual cost of $34,000, with the proviso that the city should be at liberty at any time to increase or decrease the number of lights.

THE ELECTRIC LIGHTING IN VIENNA.—The Imperial and Continental Gas Association who, as already notified in our columns, have obtained a concession for lighting Vienna, have entrusted Messrs. R. E. Crompton and Co. with the contract for supplying the requisite machinery, which will include, among other things, three of the largest dynamos, each capable of developing 100,000 watts at terminals. These machines will be driven direct by Willans' latest form of compound engine. Electro governors will also be used in this installation.

THE B.T.K. SYSTEM.—The Consolidated Electric Company has installed 108 of their No. 2 B.T.K. accumulators in the Quadrant of the International Inventions Exhibition, the coloured incandescent lamps on the tables and in the reception room at the dinner of the Civil Engineers on the 29th ult., having been run from 82 of these cells. A very successful installation of the B.T.K. system has also been completed this week at the residence of S. Courtauld, Esq., Bocking-place, Braintree, where 64 incandescent lamps have been fitted, supplied from accumulators.

DOMESTIC ELECTRIC LIGHTING.—A temporary installation of electric light was made at Lady Hervey's, Hyde Park Place, on Thursday last, on the occasion of her ball. The work was carried out by the Electrical Power Storage Company for and under the direction of Mr. F. Geere Howard, of 36, Cleveland-street, Fitzroy-square. Twenty-four lamps of 20 candle-power were used, fed by 24 one horse-power, E.P.S. accumulator cells placed in the area. These cells were brought from Millwall the same afternoon and returned the next morning. The lights were on 6½ hours.

BOOKS RECEIVED.—"The International Inventions Exhibition Railway Guide and Route Book," compiled and edited by J. R. Somers Vine, official agent of the Exhibition at the City offices, 96, London-wall, E.C., contains, besides a number of compendious time tables, &c., some useful and interesting notes for visitors.—The Specialist Series. Vol. III.: "Ballooning; a Concise Sketch of its History and Principles." By G. May. London: Symons and Co., 27, Bouverie-street, E.C.—"Proceedings of the National Conference of Electricians, Philadelphia, September, 1884." Published by W. J. Johnston, New York.

EXTENSION OF TELEGRAPHS IN CANADA.—The new telegraph line around the north Canadian shore of Lake Superior is now said to be in excellent working order, thus giving direct telegraphic connection through Canada, by the Canadian Pacific Railway route, without passing through United States territory. The train despatcher's office at Ottawa has now direct connection with the train despatcher's office at Winnipeg, with only one circuit. The distance is 1,400 miles, and messages have been sent and received with accuracy. At an early date direct connection will be completed between Montreal and the Rocky Mountains.

AN IMPORTANT EXPERIMENT.—On the occasion of a recent execution in Paris, the professors of the school of medicine were so anxious not to lose time that they went to the cemetery and began their work directly the body was replaced in the prison cart. It is pretended that the results of this examination, effected at the short interval of thirty-five minutes after decapitation, and which had especial reference to the effects on the motor regions of the cerebral substance on their being stimulated by electricity, are of extreme importance. It was ascertained that on the brain being directly subjected to excitement by electricity a movement was produced of the facial muscles.

L'ECOLE CENTRALE DES ARTS ET MANUFACTURES, PARIS.—The new school buildings erected in Paris are of an extensive character, having a frontage of 99·6 metres, and a depth of 60·9 metres. The basement contains, among other things, three large Geneste and Herscher generators for heat and ventilation, the boilers of which also serve the engines used for the generation of electricity for purposes of illumination. The electrical works of the school are said to be very remarkable. They include two engines, each of 40 horse-power, working an Edison dynamo of 200 lamps, and three Gramme machines, which latter are used alternately to actuate six ventilators, distributed over the building. The offices of the administrative body and a large amphitheatre on each story are lighted both by gas and electricity.

THE CABLE IN THE ARLBERG TUNNEL.—It is proposed to lay a gigantic telegraph cable, of a length of 10,270 metres, and weighing nearly 80,000 kilogrammes, in the tunnel of the Arlberg in Austria, inaugurated on the 15th of last August. The cable is composed of twelve conductors, of which six are reserved for the special service of the State, three to that of the railway, while the three others will be spare. Each conductor in itself consists of seven wires of copper twisted and embedded in gutta percha. Besides the insulating material and the usual serving, the cable will be wound with metallic tape, and finally bound with eighteen galvanised iron wires. It is further protected at its two extremities, *i.e.*, Saint-Antoine in the Tyrol on one side, and at Langen on the other, by two lightning conductors of large size.

THE AMEER AND THE TELEGRAPH.—The correspondent of the *Daily News* at Rawul Pindi states that among the Ameer's presents which he takes with him from India are four sets of telephones; and that it is thought possible he will consent to a line of telegraph being laid from Jamrud to his capital. This would be a great gain, as it is highly important in these critical times that we should have rapid communication with Cabul. If we could, too, get a telegraph line from Herat through Candahar to Chaman, it would be of immense benefit to us, as news now takes a fortnight to reach us, except through Mashhad, Teheran, and the Persian Gulf, which line

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is a precarious one, and would be instantly closed—or at least the section from Mashhad to Teheran—if Russian influence became paramount at the Court of the Shah, for that section belongs solely to the Persian Government.

ELECTROTYPING.—The electric machine used by the Electro-Metallurgical Company is the Elmore dynamo, which has the power of depositing one and a half tons of copper in one week, and this the finest and purest metal that can be found. The copper is deposited in tanks holding upwards of sixty thousand gallons of solution, the largest tanks being 15ft. deep by 10ft. by 12ft. in length. These large tanks are used for coating large pieces of machinery with copper, such as the rams for the recoil machinery of the big guns on board Her Majesty's ships of war, which, if not copper coated, would soon be destroyed and oxidised by sea water. A coating of as much as half an inch in thickness is laid upon these. They range from 6ft. to 10ft. in length, and are from 6in. to 18in. in diameter, but the plant is arranged to coat rams up to 24in. in diameter. An ingenious system of overhead travellers enables these heavy pieces to be suspended in the tanks, and moved about with great facility.

CHINA, DENMARK, AND THE GREAT NORTHERN TELEGRAPH COMPANY.—With reference to the conspicuous anxiety of Denmark to give a proof of her friendship for France at the expense of China in regard to the declaration of the former that rice is a contraband of war, the *Pall Mall Gazette* states that Denmark's conduct has caused the utmost surprise and annoyance among Chinese officials, who remember the extraordinary concessions which China granted to Denmark some years ago in the form of the telegraphic convention entered into between Li Hung Chang and the Great Northern Telegraph Company. It is regarded as strange that the Danish Minister of Foreign Affairs should have forgotten, when he promptly sacrificed China to France, that this convention is not yet ratified, and that the political insignificance of Denmark, which was so powerful a reason for granting to her these extraordinary concessions, may perhaps now appear to the Chinese the very reason why they ought not to have made them.

THE PHŒNIX ELECTRIC LIGHT COMPANY.—One of the numerous cases involving alleged fraudulent representation in the prospectus of new companies came before Mr. Justice Chitty on Tuesday afternoon. Mr. Dawson, an applicant for shares in the Phœnix Electric Light Company, now in course of liquidation, who on application paid his deposit of £50 on 500 shares and afterwards a first call, brought his action against the company on the ground of misrepresentation contained in the prospectus, on the faith of which he applied for shares. The prospectus, of course, contained a glowing vision of future profits to be derived from the working of Fitz Gerald's patents, already spoken highly of by Prof. Varley, for which offers had been made. The plaintiff alleged that the persons who made the offers to the company were people of no means, and that Prof. Varley's certificate was qualified by the expression that he had not had the opportunity of submitting the invention to a test of long duration. The case is likely to last for some time.

"IS THERE A TELEGRAPH TO MERV?"—The following additional particulars and corrections relating to our leading article under this title last Saturday have reached us from various sources since then. The railway to Askabad is certainly completed, General Zelensy having mentioned it as a well-known fact in his recent address to the Tiflis Geographical Society. The telegraph poles in that locality are uniformly of iron, a circumstance which disposes of M. Lessar's difficulties in respect to the local scarcity of timber. As to news by courier, O'Donovan's ride from Teheran to Shahrood, a distance of 284 miles, in 1880, was performed in two days and three-quarters, counting only from sunrise to sunset, changing horses at the post houses every 24 or 32 miles. We find that we understated our case as regards the distance of Tirpul from Meshed. It is twice that which separates Ak Tapa from Sarrakhs. Lastly, General Komaroff now admits that he received the order prohibiting the occupation of Penj-deh on 23rd March—only six days after the date of the "solemn convention."

THE ELECTRIC LIGHT AT BELLEGARDE-SUR-VALSERINE (AIN).—For very nearly a year this pretty little town has possessed an electric lighting system which will compare most favourably with that of much larger centres of population. The works are situated by the railway line from Mâcon to Geneva, upon the picturesque Valserine River, where a waterfall is utilised to furnish an available force of about 2,000 horse-power. The dynamo, which is a Thury multipolar machine, has been constructed by Messrs. Meuron and Cuenod, of Geneva. The subscribers, who are rapidly increasing in number, are able by a wise arrangement to pay for the light by the lamp, by the hour, or by the month, at the following prices:—

One 8-candle lamp.....	0·4d. per hour
One 16-candle lamp	0·8d. „
Subscription per month	2s. 4d. per 8 candles
Or	4s. 8d. „ 16 „

The lamps used are the Edison incandescent, of which a large number, of 16 candle-power, are used in the lighting of the streets.

HEATING TRAINS BY ELECTRICITY.—In the system of MM. Courcelles and Elu, heat is produced by the passage of the current through a certain number of small lead plates contained in a footwarmer, &c., of the ordinary pattern. These plates of lead are placed according to the length of the footwarmer, and are all in derivation upon two conductors of iron wire, which carry the current. In such case the heat is found to be distributed in a uniform manner. In some experiments with the current produced by a Gramme machine traversing in series five footwarmers, of which the dimensions were 0m·22 long and 0m·05 thick and 1m·80 length, each case containing 45 plates of lead, the five cases are found to be sufficient for the heating of one carriage. The current was 24 amperes, with a difference of potential of 50 volts at the terminals, and the energy dispensed was 120 kilogrammetres, or more than a horse-power and a half. From these figures it may be seen that with a train composed of several carriages this mode of heating requires a considerable amount of power, and the adoption of such a system would entail an expense which few railway companies will probably be disposed to incur.

DECOMPOSITION OF SOUND.—*L'Etoile Belge* says the celebrated physician, Logosphillos, of Athens, has by means of an apparatus resembling the telephone been able to decompose the sounds emitted by the human voice. The apparatus comprises a receiver, consisting of a very thin metallic plate, of large dimensions, connected to a multiplicity of metallic wires, of unequal length and thickness and all communicating with a dynamo machine, also connected to the receiving plate. This plate is immersed in a bath of distilled water, having the form of a prism. It is said (says our Belgian contemporary) that a prism of glass, or of water, has the faculty of decomposing light. It is proved to-day that light, heat, electricity, sound, &c., are similar forces. The photophone has demonstrated that truth, and now we are told that a prism of water de-

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composes the voice, and that each oscillation or vibration is transmitted, according to its intensity, to a special cord. The appearance of the arrangement of these metallic cords resembles that of a harp. It is dreadful to imagine what would be the result if one omitted to place *distilled* water in the apparatus of M. Logosphillos. The soft notes of one of our queens of song might by such inadvertence be reproduced in the less agreeable tones of our native Billingsgate.

THE NATIONAL TELEPHONE COMPANY.—The April list of subscribers in the Scottish North Eastern District of this company has just been issued. This list includes the counties of Aberdeen, Banff, and Kincardine, and shows that, although the first telephone was not placed in Aberdeen until 1881, there are now in operation nearly 450 instruments, a number of exchange connections, including switch lines, amounting to 425, and 29 private lines, representing together a length of nearly 260 miles of wire in the district. The longest line is that to Culter Paper Mills, which measures eight miles 447 yards. The longest private line is that of Messrs. Mitchell and Rae, from Ellon to Newburgh, five miles 870 yards. In other districts the company have much longer lines in operation, notably between Glasgow and Edinburgh, and Glasgow and Greenock. New call offices have been established at the National Telephone Company, 28, Market-street; the National Telephone Company, Arches, Wellington-road; Ellis and M'Hardy, 132, Union-street; Wm. Bain, 44, Union-place, for the use of subscribers and the general public. Non-subscribers can speak to subscribers (within a radius of six miles) from these offices only, on affixing telephone stamps to the value of 3d. for three minutes' conversation, and 1d. for each additional minute, to the call office sheet. Telephone stamps are sold at the call offices.

NEW ARRANGEMENT OF THE THERMO-ELECTRIC PILE OF MM. CLAMON AND CARPENTIER.—At a meeting of the Academie des Sciences on the 13th of April last some new models of thermo-electric piles of an improved nature were presented. The couples of these new models are of plates of iron or of nickel, and of bars of an alloy of antimony-zinc. That alloy is said to give its maximum of thermo-electric power when the two metals are mixed according to their equivalents, feeble variations in their proportions being productive of large variations in the energy of the couples. Each couple attains its maximum of electromotive force at the temperature of the fusion. This maximum is $\frac{1}{10}$ of a volt for the couples of iron alloy, and about $\frac{1}{8}$ for the couples of nickel alloy. To counteract the dangers to which the pile is exposed, when the temperature arrives at this limit the heating is arranged to maintain a sensibly lower temperature; the electromotive force utilised is then reduced to $\frac{1}{11}$ of a volt for iron alloy and $\frac{1}{12}$ for nickel alloy. Of two models which were shown one was comprised of 12 sets of 10 elements, giving altogether 120 elements. The normal electromotive force was 8 volts and the resistance 3·2 ohms. The other had 6 sets of 10 elements, giving 3·6 volts, and having a resistance of 0·65 ohm. The quantity of gas consumed per hour was the same for the two models, and amounted to 180 litres.

THE TELEPHONE COMPANY OF IRELAND.—The directors, in their report for the six months ending 31st December, say the increase in the number of wires, both exchange and private, erected during the year, and of orders received, has again been very satisfactory, the total number being 809 on 31st December, 1884, as against 647 on 31st December, 1883. The directors are in communication with the Post Office Department with a view to obtain the consent of the Postmaster-General to establish public telephone call offices at all the post offices in Dublin and the suburbs. This arrangement has been found to be most convenient by the public in Paris, where the requisite license was readily granted to the Local Telephone Company by the French Minister of Posts and Telegraphs. The line to Kingstown is opened, and working satisfactorily. It is intended to establish a public call office here, and a considerable extension of business is anticipated in this direction. The amount standing to the credit of profit and loss, including the balance of £99 10s. 3d. brought forward from last account, amounts to £1,369 0s. 8d. This admits of payment to preference shareholders of the full dividend, amounting to £550 12s. 5d., upon the preference shares. The balance, £818 8s. 3d., admits of a dividend at the rate of three-quarters per cent. per annum upon the ordinary shares, as against one-half per cent. per annum for the corresponding period of last year, leaving £162 3s. 3d. to be carried forward to the credit of the current half year.

LIGHTING OF THE ULSTER HALL, BELFAST.—On the occasion of the visit of the Prince and Princess of Wales, the ball room, vestibule, staircases, corridors, and supper rooms of the Ulster Hall, as mentioned in our last issue, were brilliantly lighted throughout by electricity. The lighting of the ball room consisted of a range of about 200 glow lamps fixed under the balcony which surrounds three sides of the hall, and screened by a draping of pink tarlatan. Six powerful arc lamps hung from the ceiling, enclosed in thick opal shades, and were further toned down with yellow and pink muslin, which transformed the ordinary somewhat trying effect of arc lighting into a tempered radiance, which it was admitted gave a most becoming effect. A novel and striking feature was a miniature iceberg, surrounded by rare exotics, and illuminated from the interior by variously coloured incandescent lamps, giving a wonderful effect, as of enormous blocks of ruby, emerald, and opal. The vestibule was also lighted by glow lamps, the central gasalier being used for one cluster, while a number of handsome brackets, with cut glass shades, surrounded the walls. Underneath the staircases were ice grottoes and ferneries, studded with incandescent lamps; and, ascending the stairs on either side, the landings were transformed into "cool grot and mossy cell," the realism of which was enhanced by falls and jets of water lighted by glow lamps in frosted bulbs, some being completely submerged, to the great bewilderment of the gold fish which flashed about in the light. In the long corridors the glow lamps again appeared in a new guise, being hung under glass shades of novel and artistic shape. The supper room was lit entirely from the roof by some 200 glow lamps in clusters of three under white reflectors, which harmonised well with the floral and general decorations of the room. In the Princess's boudoir and the Prince's room electricity was still the illuminant, cut crystal brackets being used in the former, while in the latter the lamps were concealed in the interstices of the rockery and foliage. It is satisfactory to note that Belfast is far enough advanced to be able to provide so complete an installation of electric lighting from the resources of a local company, the entire work being done by the Belfast Electric Appliances Company, whose able manager, Mr. G. Annesley Grindle, deserves every credit for the perfection of his arrangements and the complete success which attended this application of electric lighting on so extended and varied a scale to ball room decoration. It may be observed that, notwithstanding the total absence of any arrangements for ventilating the hall, the temperature throughout the evening was so pleasant as to call for universal remark, and to receive the special commendation of His Royal Highness. The power for lighting was supplied by the engine at the company's works, supplemented by a semi

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portable compound engine, kindly lent by Messrs. Fowler and Co., of Leeds, and by a special lighting plant of Messrs. Ewart and Co., which was kindly placed at the disposal of the company. The glow lamps (90 volt Victoria Brush) were run by Elwell-Parker 12-unit dynamo machines, and the arc lamps were the Belfast arcs, manufactured by the local company.

ELECTRIC LIGHTING IN BRADFORD.—A Bradford contemporary says:—That the usefulness of electricity for lighting purposes is gradually becoming more appreciated in Bradford is proved by several extensive installations which have recently been made. Messrs. John Roper and Co., of Trafalgar-street, have just completed the fitting up with apparatus for electric lighting of the rooms on the ground floor of the premises of Messrs. G. Thorpe and Co., wholesale and retail drapers, of Tyrrel-street and Ivegate. The installation comprises fifteen automatic electric arc lamps of the most approved style, each giving a light equal to 1,200 candles. The internal fittings and working parts of the lamps are mainly silver-plated. Resistance coils, which are placed in the circuit, work automatically, in order that if any one of the lights goes out the remainder are not affected. The globes are unusually large, and are made of alabaster glass, covered with wire netting, and saucers of similar glass are placed underneath to catch any particles of carbon which may fall off, and these do not in any way obstruct the light. The tops of the globes are ornamented with large gilded coronets, which give them a massive and elegant appearance. In order that the attendant who controls the light may see at a glance how much electricity is being supplied to the lamps, a current meter, an instrument answering a similar purpose in relation to electricity to that of the steam gauge in connection with a steam boiler, has been fitted up in the engine room; and, providing for the possibility of an excess of current, fusing pieces, which in such a case would melt and thus prevent damage to the machines or lamps, have been fixed in the circuit. The electricity is generated in a large continuous current dynamo machine, the superiority of which has been proved by long experience; and a Crossley gas engine of 16-horse power supplies the motive force. The effect on the light of the working of the gas engine is scarcely noticeable, special provision having been made to obviate unsteadiness by placing a heavy fly-wheel on the shaft of the dynamo. The light has been used with very satisfactory results, and will presently be in constant use at Messrs. Thorpe and Co.'s premises. A new departure has been taken in electric lighting, so far as Bradford is concerned, by an installation at Mr. F. Illingworth's residence, 5, Ashburnham-grove, Manningham. The entrance hall of Mr. Illingworth's house is illuminated by an arc lamp of 1,000 candle-power, which can be connected or disconnected at will, and a number of small incandescent lamps are switched into the circuit. A set of resistance coils is provided, by which the light may be regulated from a dull red to its full brilliancy. There is also an ammeter, which indicates at a glance the amount of electricity supplied to the lamps. The dining room is lighted by six lamps suspended from the existing chandeliers, to which the current is conveyed by flexible cords of various colours, which do not in any way interfere with the movements of the chandeliers. In the drawing room there are five lamps, similarly arranged, and fixed to ornamental pendants. In the library are three similar lamps. Switches are fixed at the entrance to each room, by which the lights in that particular room can be turned on or out. The electricity is generated by a shunt-wound dynamo, driven by a Crossley gas engine. The light has been in use for some time, and Mr. Illingworth has expressed great satisfaction with it.

THE BALLOON OF THE FUTURE.—In the May part of *Cassell's Magazine* there is a story bearing the above title, which will be found of interest to those who deal in speculative fancy. A lecturer on balloons had just retired to his own particular sanctum, when a visitor was announced, described as a tall, rather stern-looking man, with hair turning grey. He had piercing black eyes, and a rather protuberant forehead. In his hand was a small box, which he laid upon the table.

The visitor's name was Eneas Klampenberger. He was an inventor, a machinist, a dabbler in electrical science, and a student of "currents," atmospheric chiefly. His card declared him to be a "Professor;" and, indeed, it struck us that he did profess too much.

"I have come," said he, "to direct your attention to my model balloon. You, sir, I see by the papers, have been lecturing on balloons. They are useful things, but misunderstood. You must humour them. My balloon is of the future—the great future—which is rapidly approaching."

"Then I am afraid your invention is no use at present," we answered. "Wait till the future comes."

"Then it will no longer be future," he replied—"the present will have arrived—the present *has* arrived—in this box—for you. See!"

That my visitor was a madman I had little doubt, and to get rid of him was my first object. But this was more easily imagined than effected.

Disregarding all hints and suggestions, the Professor unpacked his box, and took out a small balloon neatly folded. From a corner he next extracted a pair of bellows, then a small battery, finally a cylinder, which he informed me contained a supply of "electric motive-power," stored and hermetically sealed, ready for use. This was his patent, and he retailed it in tins for the use of balloonists, as soup and meats are sold to families.

"My dear sir, there is scarcely time for any experiment to-night. I have an article to write."

"I have an article to exhibit," said the Professor, interrupting. "Do you see this balloon? Watch me. You must; you shall; you do!"

I did! I could not help it. I was fascinated, even as the prey of the snake is fascinated by the reptile—the mouse by the cat. I watched my visitor closely.

The Professor half inflated the balloon with the bellows; he then lighted a match, and with it a taper; this prepared gas-taper he held under the toy, and it swelled to all its graceful, rounded form. In the little car he fixed a twin-screw, and inside the car he placed a gas-stove, on which he heated some water. Steam was quickly generated, the twin-screw revolved with tremendous rapidity, and agitated a pair of side wings, or sails, like windmill sails, which beat the air furiously and regularly.

We were speechless. The balloon, now released, ascended half-way to the ceiling, and then round towards the window. The professor ran round the table with the bellows and blew against the model, but it still made its way against the wind, which, indeed, by feeding the sails, assisted the power of the downward stroke, and propelled the balloon upwards, as a kite is sent up, but it still went on.

"There," said the Professor triumphantly, "is not that the balloon of the future?"

"But," we asked, "who suggested the idea? and how is this balloon locomotion managed?"

"Simply by electricity and an application of the primitive laws of physics. Our motive-power by the twin-screw propeller is electricity stored in canisters, and used as required. The sails are utilised when running before the wind; the paddles for beating to windward. I steer by moving the paddles, which catch the wind and sway the balloon. See!"

One of the fluted paddles, was, for a second, turned, and the balloon's course was altered sideways instantly, as the wind acted with greater force in one particular direction.

For the conclusion of the story and the exciting adventures of the lecturer and his uncanny visitor, we must refer our readers to the pages of our contemporary.

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ALTERNATING CURRENTS.

BY THOMAS H. BLAKESLEY, M.A., M. INST. C.E.

(CONTINUED FROM PAGE 471.)

The problem of the evenly distributed condenser is somewhat different to the foregoing cases of condensers situated at points of a circuit, in that the current in the conductor at different points is neither the same at two consecutive points, nor in the same phase. Each element of the conductor has its potential continually changing by the excess or defect of the flux of electricity from and to the point considered. Thus, the phase of the potential, the phase of the current, the maximum values of both potential and current will vary according to the point of the conductor considered. Mathematical analysis will serve, therefore, rather better than geometrical demonstration.

The differential equations which express the condition of flow at a point are easily obtained.

Let E be the potential at a point P,
$E+\delta E$ be the potential at a point Q, at distance δx from P,
ρ be the resistance of unit length of the conductor,
C be the capacity of unit length of the conductor,
I be the current at P,
$I+\delta I$ be the current at Q,
δt be an element of time, and δx of length.

Then $\rho \delta x$ is the resistance between P and Q; therefore $\frac{\delta E}{\rho \delta x} = -I$, the current being positive in the direction of the increase of x. Therefore, $\frac{dE}{dx} = -\rho I$. . . . . (α)

The difference between the current at Q and P has during the time δt diminished the potential of the element P Q. Since δE is the decrease of potential and $C \delta x$ is the capacity of the element, the quantity of electricity which has left the element P Q is $-C \delta x . \delta E$, and must be equal to the balance of the current leaving and the current entering the element during the small interval δt.

$$\therefore \delta I . \delta t = -C \delta x . \delta E.$$

Therefore, ultimately

$$\frac{dI}{dx} = -C \frac{dE}{dt} \quad . . . . . \quad (\beta)$$

By differentiating (α)

$$\frac{d^2E}{dx^2} = -\rho \frac{dI}{dx}$$

and combining this with (β)

$$\frac{d^2E}{dx^2} = \rho C \frac{dE}{dt} \quad . . . . . \quad (\gamma)$$

Then these equations must be true in the complete solution of any particular case.

In the case of an infinitely long conductor, if subject to an impressed alternating E.M.F. ϵ whose period is 2 T, the time being measured from its zero phase when its value is increasing (or from the epoch of its ascending node), the solution is

$$\left.\begin{aligned} E &= \epsilon e^{-\sqrt{\frac{\rho C \pi}{2T}} x} \sin \frac{\pi}{T}\left(t - \sqrt{\frac{\rho C T}{2\pi}} x\right) \\ I &= \epsilon \sqrt{\frac{C\pi}{T\rho}} . e^{-\sqrt{\frac{\rho C \pi}{2T}} x} \sin \frac{\pi}{T}\left(t - \sqrt{\frac{\rho C T}{2\pi}} x + \frac{T}{4}\right) \end{aligned}\right\} (\delta)$$

Here x is the distance from the point at which the alternating potential has its maximum value ϵ.

The proof of these formulæ rests upon their satisfying the equations (α), (β), (γ), and the condition that when $x = 0$, the maximum value of the potential is ϵ.

Among points worthy of notice in these formulæ, is (1) that at any point whatsoever the phase of the current precedes the phase of the potential by the same interval of time, viz., $\frac{1}{8}$ of the whole period of revolution, expressed by $\frac{T}{4}$.

(2). Since the phase of either potential value or current is continually postponed in proportion to x, we have a series of points equidistantly situated along the line which are in the same phase of their alternation.

This distance is equal to

$$2\sqrt{\frac{2\pi T}{C\rho}},$$

which may be called the wave length of the undulation.

The series of points bisecting this first series are in an opposite phase.

(3). Although the total resistance of an infinitely long conductor is infinite, still there may be a considerable flow of electricity at any point, if there be capacity distributed along the conductor.

The effect of the current on the dynamometer at any point, x, will be such that if I_1 is the direct current giving the same reading on the same instrument

$$I_1 = \frac{1}{\sqrt{2}} \epsilon \sqrt{\frac{C\pi}{T\rho}} e^{-\sqrt{\frac{\rho C \pi}{2T}} . x.}$$

The reading of the dynamometer will be—

$$\epsilon^2 \frac{C\pi}{2T\rho} . e^{-\sqrt{\frac{\rho C \pi}{2T}} 2x.}$$

or, when $x = 0$, $\epsilon^2 \frac{C\pi}{2T\rho}$, which is equal to $\frac{\epsilon^2}{2\left(\frac{T\rho}{C\pi}\right)}$

By the reading of the dynamometer is meant the angle of the index on a uniform graduation in which the unit angle is that indicated when a direct uniform unit current is passing through the instrument, the coils being in series. Under these circumstances, when an harmonic current is passing through the instrument, of maximum value I, then the reading will be $\frac{I^2}{2}$.

A uniform current, I, would of course produce a reading I^2.

In what follows, therefore, the dynamometer reading may be taken to mean the value of half the square of the maximum value of an harmonic current.

The equations (δ) give the values of the potential and the current at any point of the conductor and at any time. They indicate that these quantities vary harmonically, and the factors which are outside the periodic function of the time give the maximum values of the quantities.

If we were to divide the maximum value of the potential by the maximum value of the current, we should of course get something of the order of resistance, which might in a certain sense be called the equivalent resistance. Performing this operation, this resistance will be found to be in every case $\sqrt{\frac{T\rho}{C\pi}}$.

Call this quantity B; it will be wanted in comparison later on.

Since, however, the phase of the E.M.F. lags behind that of the current by $\frac{1}{8}$th of the period, it would be instructive to make the case parallel to one in which a generator of E.M.F. equal to that at any point considered plays into a circuit of resistance r, closed by a perfectly non-leaking condenser of capacity K, and endeavour to find what values must be given to r and K, so that the current may be the one at the point considered in phase and magnitude. Then r and K may be more properly called the equivalent resistance and the equivalent capacity of the infinitely long circuit.

The necessary values are found thus :—

Since the current precedes the E.M.F. by one-eighth of the period, the geometrical diagram of the E.M.F.'s concerned will be a right-angled triangle, having each of the smaller angles equal to $\frac{\pi}{4}$.

Hence $\frac{K\pi r}{T} = \tan \frac{\pi}{4} = 1$, $\therefore K = \frac{T}{\pi r}$.

Again, the effective E.M.F. bears to the impressed E.M.F. the relation of $1 : \sqrt{2}$, as gathered from the diagram; and the

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effective E.M.F. divided by the resistance is equal to the current.

Calling α the impressed E.M.F., *i.e.*, the maximum value of E,
β the effective E.M.F.,
γ the current, *i.e.*, the maximum value of I,
for the sake of putting the above statements in algebraical form, we have,

$$\frac{\beta}{\alpha}=\frac{1}{\sqrt{2}}, \qquad \frac{\beta}{r}=\gamma.$$

$$\text{Hence } r=\frac{\beta}{\gamma}=\frac{\alpha}{\sqrt{2}\cdot\gamma}=\frac{1}{\sqrt{2}}\frac{\text{maximum value of E}}{\text{maximum value of I}}.$$

$$\left.\begin{aligned} \therefore \quad r &= \frac{1}{\sqrt{2}}\sqrt{\frac{T\rho}{C\pi}} \\ \text{and} \quad K &= \frac{T}{\pi}\frac{\sqrt{2}\cdot\sqrt{C\pi}}{\sqrt{T\rho}}=\sqrt{\frac{2CT}{\pi\rho}} \end{aligned}\right\} \quad \ldots\ldots \quad (\epsilon)$$

Thus the equivalent resistance varies as the square root of the specific resistance, and inversely as the square root of the specific capacity. The equivalent capacity varies as the square root of the specific capacity, and inversely as the square root of the specific resistance. Both quantities vary as the square root of the period. Their product is equal to $\frac{T}{\pi}$, depending merely on the period.

We have now to consider the cases where the conductor is not infinitely long, but has a length l.

The two important cases are—

(1) When the distant end is put to earth, and is kept, therefore, at zero *potential*.

(2) When the distant end is perfectly insulated, and, therefore, is subject to zero *current* at any instant of time.

These cases are in reality very similar.

Suppose, as before, that the conductor is infinitely long, and that at a point $2l$ distant from the zero point the source of another alternating E.M.F. is inserted, whose maximum value and period are ϵ and 2 T respectively, as in the primary case, but whose phase is *exactly opposite* to the E.M.F. at the zero point. It is clear, then, that the point l from the origin, since it is equidistant from both sources, has its potential raised as much by one alternation as depressed by the other, and the potential will remain, therefore, at zero. The point may put to earth. For the potential and current at any point between 0 and l we have merely to add the effects of the two alternations. We have already expressions for the primary source. Calling those due to the secondary source *reflected* potentials and currents, we have as follows :—

The reflected potential at any point and time will be

$$\epsilon e^{-\sqrt{\frac{\rho C\pi}{2T}}(2l-x)}\sin\frac{\pi}{T}\left\{t-\sqrt{\frac{\rho CT}{2\pi}}\cdot(2l-x)+T\right\},$$

and the reflected current, positive towards the origin of x

$$\epsilon\sqrt{\frac{C\pi}{T\rho}}\cdot e^{\sqrt{\frac{\rho C\pi}{2T}}\cdot(2l-x)}\sin\frac{\pi}{T}\left\{t-\sqrt{\frac{\rho CT}{2\pi}}(2l-x)+\frac{T}{4}+T\right\}$$

Combining the original effect and the reflected effect, and writing for brevity $\sqrt{\frac{\rho C\pi}{2T}}=a$, we have for the potential at any time and place—

$$E=\epsilon e^{-ax}\left\{1+e^{-4a(l-x)}-2e^{-2a(l-x)}\cos 2a(l-x)\right\}^{\frac{1}{2}}\sin\left\{\frac{\pi t}{T}-ax+y\right\},$$

$$\text{where} \quad \tan y=\frac{e^{-2a(l-x)}\sin 2a(l-x)}{1-e^{-2a(l-x)}\cos 2a(l-x)},$$

which shows that the phase of the potential is advanced by the finite conductor being put to earth, compared with the phase at the corresponding point of an infinite conductor.

The current at any point of time or place I is given by

$$I=\epsilon\sqrt{\frac{C\pi}{T\rho}}e^{-ax}\left\{1+e^{-4a(l-x)}+2\cdot e^{-2a(l-x)}\cos 2a(l-x)\right\}^{\frac{1}{2}}\sin\left\{\frac{\pi t}{T}-ax+\frac{\pi}{4}-z\right\},$$

$$\text{where} \quad \tan z=\frac{e^{-2a(l-x)}\sin 2a(l-x)}{1+e^{-2a(l-x)}\cos 2a(l-x)},$$

which shows that the phase of the current is delayed by the finite conductor being put to earth, compared with the phase at the corresponding point of an infinite conductor. We cannot, however, say that the current and E.M.F. at any point differ in phase always by the same amount. The amount varies at different points.

(TO BE CONTINUED.)

ON THE DESIGN AND CONSTRUCTION OF DYNAMOS.

BY GISBERT KAPP.

(CONTINUED FROM PAGE 433.)

In making this assumption as regards self-induction, we tacitly make another, viz., that the ring be subdivided into a sufficient number of sections. If this were not the case the self-induction of each single coil would be considerable, and would vary within wide limits as the current varies. In this case it would not be admissible to simply allow a small percentage of loss of electromotive force, but a much more complicated calculation would be necessary. In practice, however, and especially in incandescent machines, the number of sections in the commutator is always reasonably large (between 24 and 100), and hence the allowance to be made for loss through self-induction very small. Before leaving this subject it will be interesting to point out by the aid of our mechanical model (Fig. 11) the difference existing between arc and incandescent machines. On

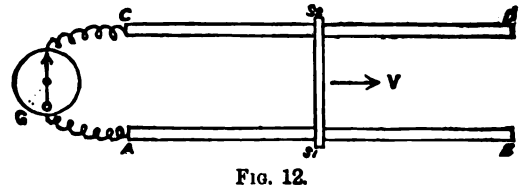

FIG. 12.

account of the greater multiplication of turns in each coil of an arc machine the self-induction is greater than in the coil of an incandescent machine of equal electrical output. That corresponds in our model with an increase of weight of each single roller, and the friction in the journals of each roller is also greater (increased resistance of a larger number of turns of finer wire). If we give the roller sufficient time this increased friction will be nearly or quite sufficient to bring it to rest before the power is applied which reverses the motion. In other words, the angle A O B must be the larger the heavier the rollers. As a matter of fact, we find that the brushes in arc machines are made to lie flat or tangentially on the commutator so as to ensure a greater angle of contact, whilst in incandescent machines the brushes are placed almost end on and the surface of contact is only a little wider than the thickness of the brush. We can now enter into the question of how to calculate the electromotive force of a given dynamo, and in order to place our formulæ on a scientific basis it will be necessary to briefly refer to the absolute units of electromotive force, current, and resistance.*

Let (in Fig. 12) A B, C D be two straight parallel wires placed in a magnetic field of given uniform intensity, I. This means that every square centimetre of surface contained between the two wires is traversed by I lines of force running at right angles to the plane A B C D. The ends A C of the wires are connected with a galvanometer, G, and the circuit is

* See A. Gray's "Absolute Measurements in Electricity and Magnetism;" also Thompson's "Dynamo Electric Machinery."

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completed by a sliding wire, $s_1 s_2$, which is moved in the direction of the arrow with a velocity of v centimetres per second. If d be the distance between the two parallel wires, the area enclosed by the circuit will be increased through the movement of the slider at the rate of $d v$ square centimetres per second, and the number of lines of force enclosed by the circuit will be increased at the rate of $d v$ I lines per second. The slider, therefore, cuts $d v$ I lines per second, and in doing so it produces a difference of potential between the points s_1 s_2, which in absolute measure is equal to this number of lines. We can therefore write $e = d v$ I. The unit of electromotive force will be produced if each of the three factors d, v, and I are equal to unity—that is, if the parallel wires are one centimetre apart, each square centimetre contains one line of force, and the velocity is one centimetre per second.

Assume that only the slider have a resistance r, but that the galvanometer and the parallel wires have absolutely no resistance. In this case the current indicated by the galvanometer will be expressed by $\frac{e}{r}$, and unit current will be obtained if $e = r$. In a unit field d I $= 1$, and therefore $r = v$. The resistance of the slider can be expressed as the velocity in centimetres per second at which it must be moved across a unit field so as to produce unit current. The relation between these absolute units and the volt, ohm, and ampere employed in practice is as follows :—

One volt equals 10^8 absolute units of electromotive force.
One ohm equals 10^9 absolute units of resistance.
One ampere equals 10^{-1} absolute units of current.

To produce in our slider a difference of electromotive force of one volt, it would have to be moved across a magnet field of unit intensity at a speed of 1,000 kilometres per second. This is an inconveniently large, or, to speak more correctly, an impossible speed, and to reduce it we must employ a stronger field, and increase the distance between the wires. To fix ideas by an example, let us assume that the speed of the slider shall be limited to 10 metres a second, which corresponds to about 22 miles per hour, and is a very moderate speed for the periphery of armatures in dynamo machines. Then to obtain one volt the product d I must equal 100,000, which can be obtained by employing a slider one metre long in a field which contains 1,000 lines of force to the square centimetre, or by a slider 10 centimetres long in a field containing 10,000 lines to the square centimetre, or with any other combination, giving the same total number of lines cut per second. What is the maximum number of lines which can be produced per square centimetre is not definitely known; some say 11,000, others 13,000 to 14,000. In practice, however, such an intensity is never reached. In good machines there are from 6,000 to 8,000 lines to the square centimetre of armature core, which with a drum armature would give about $\frac{6000}{\frac{1}{2}\pi} = 3{,}800$ lines to every square centimetre of the field. Suppose a machine could be constructed, the field of which were formed between the polar surfaces of two magnets standing opposite—something like the Elphinstone-Vincent dynamo—and with just sufficient clearance between them for the armature wire (corresponding to our slider) to pass, and an unlimited exciting power were employed, we would get an ideal dynamo, giving a maximum of electromotive force with a minimum length of wire. At a speed of 60 miles an hour every inch of wire would give about one volt. Such results are, however, not attainable in practice, and we must be content with a much lower electromotive force per inch of armature wire.

Let in Fig. 13 N and S be the poles of the field magnets, and A, B, C, D a drum armature of radius a and length b. The lines of force enter the core above and leave it below, and those lines contained within the rectangle, 2 a b, are useful in producing electromotive force. Let I be the intensity of the field expressed by the number of lines per square centimetre of air space between the polar surface and the armature core. This quantity is never constant throughout the field, but, as is well known, is greatest at the corners of the pole pieces. The exact distribution of lines could be ascertained by an instrument similar in principle to that employed by Mr. Gordon in his alternating current dynamo for the same purpose, or by the method described by Prof. Thompson in his book on dynamo electric machinery. For the present we need not concern ourselves with the exact determination of every part of the field, but we assume that the strength of the field varies in a certain way with the angle α—in other words, that it is a function of α. We can therefore write $I = f(\alpha)$. Assume that the angular distance between two succeeding coils be Δ, and that there be N t external wires, if counted all round the circumference, so that Δ N $t = 2\pi$. It has been shown above how the electromotive force created in a wire depends on the speed at which it moves across the lines of force. Other things remaining the same the electromotive force is simply proportional to the speed. We can therefore assume, for the purpose of our investigation, any convenient speed, and calculate for it the electromotive force. To obtain the electromotive force at any other speed we would have to multiply the result first obtained by the ratio of the two speeds. Assuming, then, that the angular speed of the armature is exactly equal to the angular distance of two neighbouring coils, the wire W_1 would require one second to reach the position previously occupied by its neighbouring wire W_1', and similarly the opposite wire W_2 will advance in one second into the position of W_2'. The electromotive force created in W_1 is evidently $a b \Delta f(\alpha)$, and the sum of all the electromotive forces created in all those wires which are above the horizontal diameter A C is $\Sigma_{\alpha=0}^{\alpha=\pi} a b \Delta f(\alpha)$.

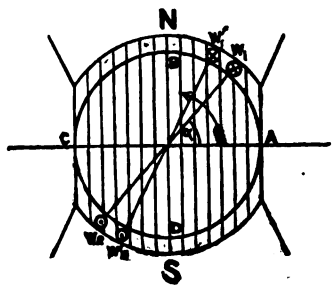

FIG. 13.

Now a, b and Δ are constants, and $\Sigma_{\alpha=0}^{\alpha=\pi} \Delta a f(\alpha)$ is simply the sum of all the lines of force entering the armature core per centimetre of its length above the horizontal diameter A C; and $b \Sigma_{\alpha=0}^{\alpha=\pi} \Delta a f(\alpha)$ is the sum of these lines over the whole length b of the armature. From this it follows that the total electromotive force only depends on the total number of lines passing through the core, but not on the way they are distributed. In consequence of the manner in which the coils are connected up with each other and with the commutator, all the wires above the diameter A C are for the time being placed in series, and similarly all those below A C are in series, the two halves of the armature being at the same time in parallel connection. Let Z be the total number of lines passing across the armature core, then the total electromotive force created within the armature coils is

$$E = Z,$$

the speed being, as assumed above, only equal to $\frac{\Delta}{2\pi} = \frac{1}{N t}$ revolutions per second. If we were to drive the same armature at a speed of n revolutions a second, every thing else remaining the same, the electromotive force would be increased in proportion to the ratio of speeds; that gives

$$E a = Z \frac{n}{\frac{1}{N t}}$$

$$\text{or } E a = Z N t n$$

The electromotive force equals the product of the total number of lines passing across the armature core with the number of external wires, and with the number of revolutions per

second. If Z be given in absolute measure, E a will also be obtained in absolute measure.

In deducing the above formula, we started from a drum armature wound on the Siemens-Hefner-Alteneck principle. The result would have been the same had we taken a Gramme armature as the basis of our investigation, provided we do not count those lines which pass across the central space of the armature. It is evident that a line passing through the central space in the armature must be cut by the inner portion of the coils, and thus create in them an electromotive force opposed to that which is created in the outer coils by the

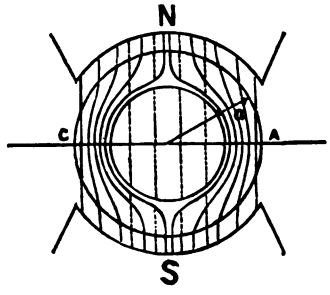

FIG. 14.

cutting of the same line. These lines (dotted in Fig. 14) going straight across the central space contribute, therefore, nothing to the total electromotive force, and must not be included in the value of Z. All the useful lines take the path as shown in full in Fig. 14, and in order that there may be a preponderance of these over the useless lines the space available for their accommodation should be considerable, or, in other words, the radial depth of the core a should be sufficiently great in order that the density of lines should be within the limit of 6,000 or 8,000 lines per square centimetre of core

(TO BE CONTINUED.)

OLD CABLE STORIES RETOLD.—VII.

BY F. C. WEBB.

(CONTINUED FROM PAGE 68.)

THE RED SEA AND INDIA CABLE OF 1859—60.

I left Suez on November 30 for Aden, with Mr. Brunton and Mr. Mayes, in the P. and O. steamer "Emeu." On the 1st December the thermometer was only 75° in the shade, but by the 4th it was 92° on deck, 93° in cabin, 117° in engine room, and 150° in stoke hole. The ship was very crowded.

On the 5th we passed the wreck of the "Alma," on board which ship Mr. Gordon (of Newall, Liddell and Gordon) and Mr. Lionel Gisborne were passengers at the time of the wreck a few months before. They were taken off the island by H.M.S. "Cyclops." We arrived at Aden on December 7th. Mr. and Mrs. Newall were there waiting for the "Imperidor" and "Imperatrix" to arrive. Mr. Long (formerly, and, I believe, now again with Negretti and Zambra) was superintendent in charge at Aden. We arrived at Bombay on the 15th; left the next day for Kurrachee in a wretched steamer called the "Scindian." She only went six knots an hour, and yet we had to stop at night to cool bearings. Arrived on 20th at Kurrachee. Found H.M.S. "Cyclops" there, and we breakfasted on board her; then to Europe Hotel, a curious little building, with a round tower at each corner just like a small Bastile. The only other persons in the hotel were four officers, just down from Delhi, and who had been through the Indian mutiny.

The "Imperidor" arrived and anchored outside on the 24th. A length of 200 miles of cable had been laid several months before from Aden towards Kooria Morria Islands. The "Imperidor" had on her way from Aden hooked up the end and found it covered with coral. The length had become faulty. Mr. Newall at first refused to take Mr. Mayes on board. He had also refused to take from Aden the furniture for Khooria Mooria and Muscat, and had also refused to bring on my batteries, which I had brought as far as Aden, and he refused me a passage in the paying-out ship, although I had a special order from the Board of Directors. He even tried to get Mr. Forde to go in one of the accompanying men-of-war.

The position of the engineers for what may be termed the buying company in submarine telegraphy has always been a peculiar one. The ship and staff for laying the cable are under the contractor, and the unfortunate engineers for the buying company are entirely at the contractor's mercy. I know this from my own experience. I have had also, however, to act for contracting firms as their agent, and I have always looked upon the representatives of the telegraph companies as gentlemen whom it was the interest of my employers to conciliate as far as possible, consistently with a due regard for the solid interests of my employers. But I am afraid this has not always been the key note of many submarine contractors or their agents.

After reams of correspondence at Kurrachee it was finally arranged between Mr. Brunton and Mr. Newall that I should take passage in H.M.S. "Retribution" (32-gun paddle frigate), which ship had arrived at Kurrachee to assist in the expedition.

On January 13 I went on board the "Retribution," commanded by Commodore Harry Edgell, and was introduced to the ward room mess. Fortunately there was a spare ward room cabin, in which I was installed. It was as dark as Erebus, and indeed the ward room itself was nearly as dark as it was on the lower deck, and the after part where the stores, &c., were kept had constant lights burning in the day time.

On the 13th, the "Imperidor" and "Imperatrix" brought up close to Manora Point. The end was landed from the "Imperidor" at 8 a.m., and at 2:10 p.m. she commenced to pay out the first cable for joining India with Europe. She paid out at about 5 knots. We skirted the Mekran coast, and on 14th were going 6½ knots. At about 5 p.m. we sighted H.M.S. "Cyclops" which had gone ahead to sound, and at 5:30 she joined the expedition. At noon this day 119 miles had been run. On 15th "Cyclops" had much difficulty in keeping up with the rest of us, as we were going 7 knots. We went on ahead, sounded, found 15 fathoms and anchored at 2 p.m., 173 miles from Manora Point. "Imperidor" came up paying out and anchored. "Cyclops" reported having sounded across towards Muscat and found 1,900 fathoms as deepest water. On the 16th we got under way at 7:30 a.m., and kept W. by S. in 12 to 16 fathoms. At about 9:45 deepened water, deepened to 500 fathoms by noon. At 10:45 p.m., 99¼ on patent log; "Imperidor" fired rocket. Answered it, and changed course to S.W.W½., and we plunged towards the dreaded deep water. On the 17th high land near Muscat in sight, about 15 miles off; by 9 a.m. went on ahead near to where cable was to land. Noon "Imperidor" arrived. Made signal "Congratulate you." As they came up to us we accompanied them, the ship's company cheering, and the band playing "See the Conquering Hero Comes" (192 by patent log). "Imperidor" brought up to splice on shore end, to pay out to a small bay on the south-western side of Muscat Harbour. The "Retribution" then went into Muscat Harbour, and saluted the flag of the Imaum of Muscat. It was found, however, that although 22 guns were loaded, only 20 had been fired, and the Commodore sent ashore a lieutenant to apologise, and to offer to fire the salute over again, but this was politely declined by the Imaum. The salute was returned by the Imaum from batteries in various concealed places high up amongst the rocks that tower round the harbour, and was a most peculiar sight, which was even novel to the experienced and travelled officers of the ship. Two or three guns were fired apparently out of the rocks in one place, and this was taken up by three or four on the opposite side high up, and then the other side would take it up on a lower level, and you could never tell where the next were coming from, so perfectly concealed were the batteries of this old kind of pirate's nest. Our boats then towed a French sailing frigate further up the harbour.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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CONDENSERS.

We invite those of our readers who are Electricians and who have Condensers in their charge to kindly furnish us with information as to the actual capacity of such Condensers as against the nominal value; together with a note of the temperature readings with both wet and dry bulbs; and any other data which may be of interest.

THE INVENTORIES.

Judging by a cursory inspection at the beginning of this week, we might be inclined to predict that the Exhibition of Inventions will not be ready for the opening ceremony on Monday next; but the general activity which prevailed on the premises, the progress made under our very eyes, and the solemn assurances of the management that all would be ready in good time, incline us to take a hopeful view of the situation. Exhibitions are usually behind time, owing to the dilatoriness of the exhibitors. But in this instance it is well known that the offers of exhibits long ago far exceeded the possible space available; and it is perhaps partly on account of the abundance of exhibits actually on the spot that the Commissioners express themselves confident that the Inventories will be quite exceptional in the way of completeness on the day of opening.

Be this as it may, the enlargement of the area of accommodation, the intrinsic interest of the objects to be exhibited, and the many additional provisions made for the comfort and enjoyment of visitors, both inside and outside the exhibition building, leave no room to doubt that, weather being favourable, the forthcoming show will be as popular as the last. People who, under the sanction of authorities on Health, partook of unwholesome drinks, kept late hours, and revelled in crowds which, if not certainly unhealthy, were probably extremely mixed, will not be deterred from taking their recreation in a similar fashion as patrons of Invention. Many, if not most, of these votaries of science probably hold with the saying that the man who invents a new pleasure is the greatest benefactor of his kind. The Inventories, although not altogether a new pleasure, is at all events another; and those who seek for it will find it where they found the last.

There is often a good deal of cant in the talk about combining amusement with instruction; but in sober earnest we see no harm, but rather considerable good, in getting the public to take even a passing stroll through the wonderland of science, even if their ultimate goal be the temple of bliss just over the border. It is impossible to mistake the general impression made on the vast majority who witness such a spectacle as that which will be repeated on Monday next. It is one of wonderment, admiration, and even of awe. It is a sort of revelation to mankind in the aggregate of the great things mankind in particular is capable of achieving; and it increases the general reverence for the exceptionally gifted of their race who employ their talents for the common good of all. Genius is thus encouraged by widening the circle of its admirers; and on the whole genius will not be jealous of the humbler and less serious attractions thrown in as a concession to the weakness of average humanity.

One immense advantage of these South Kensington gatherings is that they are not got up primarily with the object of paying. In reality, and perhaps on this very account, they do pay. But this is not the first consideration; and consequently the arrangements are all on an exceptionally liberal scale. This is manifest in the item of Electric Lighting, which, we believe, will be almost exclusively employed both inside the buildings and for the ornamental gardens in which they stand. A great opportunity will thus be afforded of displaying the many improved devices which have been perfected during the past year. Whatever is new in this department is sure to be found there. One at least of our contemporaries has already, as heretofore, been busily describing things which are certainly not yet there; but on the present occasion we almost expect to see them duly in their places before the season is over, and we hope they may answer to their somewhat premature descriptions.

To inventors themselves—and we allude, of course, more especially to those engaged in electrical improvements—these annual exhibitions serve the double purpose of advertising the wares of the inventor and informing him of the progress or deficiencies of his rivals. On these occasions everybody has an interest in making his ingenuity and researches as widely known as possible; and it follows that by general comparisons on a scale of such magnitude as the present the Inventor's own education will be greatly improved. It is better to learn that we have failed than to waste time on something that has succeeded in other hands.

Exhibitors of electric lighting appliances have again to be thankful for the publicity afforded by this popular exhibition for the display of the new illuminant. The installations, we are confident, will be carried out in a workmanlike way, and on scientific principles. The light will have the advantage of being seen at its best; and the public will receive one more proof of its beauty, its servicableness, and its wholesomeness

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during the hottest months of the year. It is now past hope that anything will be done during the present Session to rectify the injustices of the Electric Lighting Act. But the lighting of the Inventories is some compensation; and it may prove to be a lever with which even that huge obstruction invented by the Board of Trade will be cleared away.

SUBMARINE TELEGRAPHY.

A general misapprehension prevails in many quarters as to various questions relating to submarine telegraphy. The letter of Sir James Anderson given elsewhere summarises and emphasises the cardinal points to be kept in view—not only in the commercial considerations but also in the political—for the maintenance of cable communication. The primary object, commercially, is to connect points where sufficient business will be developed to obtain a fair return upon the capital expended. The mere laying of a cable between two points is comparatively uninteresting, the questions to be solved are, rather, probable business and cost of maintenance. Either of the three great manufacturing companies would undertake to manufacture and lay a cable between any two points; but the maintenance of the cable is another matter. A somewhat thoughtless suggestion has been made by a contemporary to lay a direct cable between the Cape and India, passing to the eastward of the Mauritius. The objections to such a cable are manifold. The capital required would not be less than one million, the traffic would be small, the cost of maintenance large. With regard to the maintenance, the configuration of the bed of the Indian Ocean is practically unknown, but what is known of it is not reassuring. The depths are great, and experience has shown that the bed is liable to severe vulcanic action. Add to these the surface troubles of currents, winds, and storms, and the look-out is still worse.

Capitalists would not risk their money to carry out such a scheme. The business would simply be that arising between India and the Cape, which is not very great; and this would, of course, be divided between the two routes. We shall say little of the political question, which is outside the commercial question. The necessities of politics are best known to politicians. It is certain, however, that, whether a cable is laid for commercial or political purposes, or a combination of the two, the ability of a foe to injure it remains the same. Sir James Anderson is clear that the cable should be in frequented waters. Natural or wilful damage must be guarded against by despatch boats, and the shorter the distances to be thus bridged the less the evil. In case of war the Government should not only organise a service of swift cruisers to protect the merchant vessels, but every cruiser should be on its guard to protect the cable communications, and should carry one or two men skilled in cable work. These men could grapple for a cable in certain places, connect it up to the instruments on the ship and send cypher messages through, which might be of great value, and this in absolute secresy. Of course it would be necessary to provide a secret code for this purpose.

OBITUARY.—The death is announced of M. Jules Dûcoté, one of the delegates of France at the Conference of St. Petersburg, and who was Director of Postal Telegraphs of the Seine, Paris, at the time of his decease. M. Dûcoté was educated at the Ecole Polytechnique and was connected with the French Administration since the year 1851, during which time he carried out many important works in the technical department of the administration.

CORRESPONDENCE.

PROPOSED CABLE BETWEEN WESTERN AUSTRALIA, MAURITIUS, AND NATAL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of 25th April, quoting from the Mauritius Correspondent of the *Natal Mercury*, it is said the apprehensions I entertain in regard to maintaining submarine cables from the Cape, *viâ* Mauritius, to Australia have been referred to Dr. C. Meldrum, F.R.S., an able meteorologist, who has given it as his decided opinion, *as regards storms*, that this telegraphic route is safer than the route between Ireland and Newfoundland.

I ask leave to say in reply that as regards the frequency of storms I agree with him; but I cannot believe he will differ from me when I say—

1st. That the trade winds along the track referred to are for the greater part of the year strong, and always within two or three points in the same direction.

2nd. That the prevailing winds between Mauritius and the Cape have the same peculiarity.

3rd. That the Agulhas current is so strong as to make the maintenance of a submarine cable as nearly impossible as physical conditions can make it.

4th. That the distance between the points named is excessive, and so are the depths of these broad oceans.

I have crossed the track thirteen times, and my opinion is that it would be very difficult to grapple for a broken cable across the line of wind, waves, and currents which there prevail.

5th. There are hurricanes of overwhelming violence in the region of the trade winds and Mauritius, and a repairing steamer must be large, with great coal endurance, to undertake the repairs in those seas.

6th. For a cable to be of any use commercially between points so distant the conductor must be large, necessitating a larger external covering and ships of greater tonnage to lay it, therefore more expensive in all respects than cables meant for moderate distances.

It is not saying much to say that as regards storms this route is safer than the Atlantic, because irrespective of storms we are seldom in the Atlantic without one or more broken cables.

Two have been broken ever since last September; there are four broken just now. All cables break and require repairs. Some may escape for a few years, but as they get older it is illusory to imagine that they will not break, need repairs, and *renewals*.

I could say more of a disappointing character if I had any real object in preventing cables from being laid between the points referred to; but I have no special desire in the matter. My real point in replying to this notice is to put on record once more, and as briefly as possible, what I do think should be the principles which should govern the selection of a route for submarine cables.

a. Cables should be laid as far as possible where they can most easily be got at to repair.

b. They should be laid in as short sections as convenient—touching at as many points as are likely in the near future to develop some traffic or commercial intercourse of any kind.

Speaking generally, the most useful and economical lengths for cables are from 500 to 1,000 miles, and the depths which we would all select if we could would be between 300 and 1,000 fathoms.

c. Cables should be laid as much as possible along the track usually selected by our mercantile marine, for the two special reasons—1st. When any interruption takes place the broken section can until repairs are effected be more frequently bridged over, and there are more chances of chartering a steamer to continue going between the interrupted points if the interruption seems likely to be prolonged. 2nd, and very important. In time of war the national armed cruisers appointed to patrol the track of our commercial marine would at the same time be guarding the track of the cables.

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It is all very well to lay cables across great oceans if there is no other way of getting at the points desired, but in my judgment every useful purpose is best served by cables which internationally, intercolonially, and amongst islands touch at as many points as offer some chance of promoting commerce.

For all these reasons any additional cables for Australia will give the best results if they are laid amongst the very numerous and important islands in proximity to the great Australian colonies, and from which more than any other community they will derive the greatest amount of good from any commercial development that may accrue.

In my opinion all money expended in cables across broad oceans, where it can be avoided, is money thrown away.

In time of war they can be easily broken. They can never be easily, quickly, or cheaply repaired. They are therefore strategically unreliable, and in their first cost and maintenance more expensive than those laid as I have suggested.—Yours, &c.,

London, April 27th. JAMES ANDERSON.

PROFESSOR FORBES' REPORT ON THE B.T.K. BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Prof. Forbes' report on the B.T.K. storage battery, however instructive and satisfactory it may be to the Consolidated Electric Company, I venture to ask of what value is it to those seeking a suitable battery for electric lighting?

We are given two columns of figures (presumably watts), marked "charge" and "discharge," but nothing is said of the rate at which these operations were carried on. The discharge apparently was carried to the extreme point, as the report speaks of several cells having lost their E.M.F.

I am, however, most surprised at the report regarding an "output" as practical when the E.M.F. had fallen 18 per cent., and am interested to know if, in calculating the efficiency, the discharge was carried to this point.

Of what light-giving value would a normal 45 volt 20 candle-power lamp be if the E.M.F. were allowed to drop to 37 volts? Probably 4 or 5 candle-power.

Later on a test is recorded of a specially-prepared battery in which a drop is allowed of 14 per cent. in E.M.F. This is also too great, as for satisfactory electric lighting by incandescent lamps the maximum drop should be 5 per cent.—Yours, &c.,

M. RUDDLE, A.S.T.E. and E.

5, Wellington-terrace, Barton-road, Stretford, Lancashire. 27th April, 1885.

PROF. FERRARIS' EXPERIMENTS WITH GAULARD AND GIBBS' GENERATORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I enclose a copy of a letter I have just received from Prof. Ferraris.

I avail myself of his kind permission to send it to you, because I know that it will be most agreeable both to him and to me that it should be known that we are agreed upon this matter.

Prof. Ferraris is in no way in fault. The mistake has arisen from my not being sufficiently explicit.—Yours, &c.,

J. HOPKINSON.

(Copy.)

Turin, April 26th, 1885.

Dr. Hopkinson, F.R.S.

Sir: I thank you heartily for your letter of 21st inst., in which you give me explanations in regard to the method you adopted in determining the efficiency of the secondary generators of Gaulard and Gibbs. Your account which I read in the *Electricien*, of Paris, April 15th, 1884, p. 344, the only one which you had published, only said that your measures were done by means of a quadrant electrometer by the method followed some years ago by M. Joubert in Paris, and this caused me to believe that you had calculated the energy absorbed by the secondary generator by multiplying the mean difference of potential by the mean strength of the current. M. Gaulard had besides strengthened my opinion, so that I thought it unnecessary to write directly to you in order to ask information.

Therefore I was innocently induced to put down your name amongst those of the experimenters who inexactly interpreted their experiments. The explanations you now kindly give me in your letter convince me that I have misunderstood you, which makes me very happy, because I like very much not to be at discord with a man of science whom I esteem highly.

You have done well in publishing your letter in the journals in which abstracts of my paper have appeared. I authorise you to do the same with the present if you think that it is convenient.—Yours, &c.,

(Signed) Prof. Galileo Ferraris.

A WORD.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I notice in your last issue a paragraph relating to the need of a word to express a telephone message.

The words suggested appear to me of doubtful etymology, or so like the word "telegram" as to perhaps cause confusion.

By the word I would suggest the etymology is preserved, but by simply reversing the order of the component parts of the word "tele-phone" a quite distinct word is obtained, and one that cannot be confused with "telegram," "telephone," &c., namely, "Phōnētĕl" (φωνητελ).—Yours, &c.,

29th April, 1885. C. S.

ON THE SEAT OF THE ELECTROMOTIVE FORCES IN THE VOLTAIC CELL.*

BY PROFESSOR OLIVER J. LODGE, D.SC.

(CONTINUED FROM PAGE 497.)

18. Not many measurements of metal pairs have been made, even in air; for mere permutations such as copper-tin, tin-silver, &c., follow at once from the numbers given above by Volta's series law; but in gases other than air one has at present no experimental guidance beyond the barest qualitative one given by Mr. Brown, that copper-nickel reverses its sign when changed from air to hydrochloric acid, and that copper-iron is reversed in sulphuretted hydrogen. But satisfactory observation in these gases is difficult, because they not only *tend* to attack the plates, but they *do* attach them; and so a film is formed and everything is rendered uncertain.

TABLE A.—Energies of Combination of Metals with Chlorine; and Calculated Volta Series in that Gas.

Metal.	Molecule.	Authority.	Heat of Combination.	Calculated Volta series, in Volts.
Zinc	Zn,Cl_2	Thomsen.	97210	2·1
	,,	F. and S.	100592	
	,,	Andrews.	101316	
Lead	Pb,Cl_2	Thomsen.	82770	1·8
	,,	F. and S.	89450	
Iron	Fe,Cl_2	Thomsen.	82050	1·78
	,,	F. and S.	99302	
Nickel	.....	No data.		
Copper	Cu,Cl_2	Thomsen.	51630	1·12
	,,	F. and S.	59048	
	,,	Andrews.	60988	
Mercury	Hg,Cl_2	Thomsen.	63160	1·38
Silver	2(Ag,Cl)	,,	58760	1·28
	,,	F. and S.	69600	
Hydrogen	2(H,Cl)	Thomsen.	44000	·96
	2(H,Cl,aq.)	,,	78640	
	2(H,Cl)	F. and S.	47566	
	2(H,Cl)	Alvia.	48174	
Potassium	2(K,Cl)	Thomsen.	211220	4·62
	,,	F. and S.	201920	
	,,	Andrews.	208952	
Sodium	2(Na,Cl)	Thomsen.	195380	4·24

Another complication results from the fact that, when metals are taken out of air and put into a foreign gas, they are already coated with a film of oxygen, and it is not clear in what way this will affect the action of the

* Reprinted from the *Phil. Mag.* for April.

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new gas. It may have to be replaced almost by substitution ; the affinity to be considered in chlorine, for instance, being something like M, Cl_2 – M, O. In a compound like HCl, the hydrogen also may have to be provided for, the resulting chemical strain being, for instance, M, Cl_2 – M, Cl + H_2, O – 2(H, Cl) ; but the consideration of the hydrogen affinities will not affect *differences*, and therefore will leave comparisons with experiment unaffected. Taking the metals as clean, however, and without air-films, we must suppose the series (Table A) to be right.

This series will hold, as far as *differences* are concerned, for hydrochloric acid also ; because, whatever effect the hydrogen affinity may have in changing the numbers, it will have the same effect on all.

It is easy to write down the hypothetical series in bromine and iodine in the same way :—

Calculated Volta Series in Bromine and Iodine.

Metal.	In Bromine.	In Iodine.
Potassium	3·85	3·50
Zinc	1·74	...
Lead	1·40	·87
Silver	1·10	·60
Copper	·89	·23
Hydrogen	·40	– ·13

All this supposes the metals to be perfectly clean, and not covered with a film of foreign gas like oxygen. On the hypothesis that the metal has been taken recently out of air, and that the film of oxygen with which it is covered has to be torn from the metal, though it was not actually combined with it, the Volta series in chlorine or hydrochloric acid would be quite different, and more like this.

Hypothetical Volta Series of Air coated Metals in Chlorine or HCl.

Silver	1·8
Lead	1·2
Iron	1·1
Copper	·9
Zinc	·85

Unfortunately I can get no data for the heat of chlorination of nickel ; but assuming it not very different from iron, the above series gives copper and nickel in the right order, as observed by Mr. Brown, whereas the other one did not. I have no experiments with which to compare the numbers.

Calculated Volta Series of Clean Metals in Sulphur or Sulphuretted Hydrogen.

Metal.	Heat of Sulphurisation per gramme equivalent.	Volts.
Potassium	91276	1·95
Zinc	41880	·87
Iron	35506	·76
Lead	19112	·41
Copper	18266	·39
Silver	11048	·34
Hydrogen	5482	·12

But it will be observed that this is nothing like the order to be expected in sulphuretted hydrogen ; for it is popularly known that copper is more easily sulphurized in this gas than iron. Now assuming that the metal had been covered with an air-film, and that the oxygen of this has to be replaced by sulphur, the chemical tendency, instead of being M, S, is something more like M, S – M, O, or possibly M, S – M, O + H_2, O – H_2, S ; and either of these will give a quite different order. Data are given on p. 624 of Naumann's *Gmelin-Kraut*, vol. i., for the neutralization-heats of various bases by H_2S, such as CuO + H_2 S, &c. These are something like what we want, and from them we reckon the following :—

Hypothetical Volta Series, in Sulphur or Sulphuretted Hydrogen, of Metallic Oxides, and possibly of Air-coated Metals.

Metal.	Heat of reaction, MO + H_2S = MS + H_2O.	Volts.
Silver	55800	1·20
Mercury	41700	1·04
Copper	31600	·68
Lead	26600	·57
Zinc	19200	·41
Iron	14600	·31
Sodium	7700	·16

The series so obtained gives copper and iron in their proper order ; but it is scarcely likely to be really correct, because it assumes that the *oxides* of the metals are exposed to the gas rather than the metals themselves. It is quite possible that it is not very incorrect for tarnished metals, *i.e.*, metals coated with a film of oxide ; but for ordinary clean metals, coated, not with a film of oxide, but with a film of oxygen, it is nothing but a rough approximation, given because have no better data.

It is to be noted that, as the film of oxygen diffuses away, the Volta-effect depending on it must diminish until at length the active affinity causing the chemical strain is nothing more than M S, or perhaps M S – H_2 S. A gradual falling off and ultimate even reversal of sign was observed by Mr. Brown in both HCl and H_2 S. In so far as actual chemical action occurs and a film of chlorido or sulphide forms, so far of course also will the effect diminish, because it depends essentially on the unsatisfied chemical strain, not on the accomplished chemical action.

Additional Note, March 13th, 1885.

On page 176 of the March Number of the Philosophical Magazine I quote from Von Zahn and others an extraordinary statement, ascribed to Professor Exner, that a thermopile ceases to work in a vacuum, saying at the same time that I had been unable to find the statement myself in Exner's writings. For a sufficient reason as it now turns out, because it is not there.

Turning over some back volumes of 'Nature' recently, I accidentally came across a letter from Professor Exner in vol. xxiii., p, 170, December, 1880, denying that he had ever said such a thing, and maintaining that his memoirs were quite clear on the subject of the relation, or rather want of relation, between voltaic and thermoelectric phenomena. This is perfectly true. Professor Exner has expressed himself on this subject with decision, and finds fault with Professor Edlund for ever confusing the two distinct things together.

In the same volume of 'Nature,' on page 312, appears a note from Professor Young acknowledging that he ought to have been more careful to refer to the original statement, and giving one of the "Physical Notes" of 'Nature,' p. 156, vol. xxii., as his authority. This "Physical Note" quotes from *l'Electricité*, and so the error, however originally manufactured, gets handed on from one paper to another.

One of the memoirs which I have unfortunately overlooked in my historical sketch of the experimental work done in connection with the subject has come to hand this morning, through the kindness of the authors, MM. E. Bichat and R. Blondlot, of Nancy. It was published in the *Comptes Rendus* (1883), t. xc. pp. 1202 et 1293, and in the *Journal de Physique*, 2e série, ii. p. 533, and is an attempt to measure the Volta effect for two liquids. The method employed involves the use of three vessels, A, B, C, of which A and C contain one liquid and B the other. A and B are then connected by a liquid siphon with porous diaphragm [the capillary E.M.F. possibly excited by this diaphragm is bad] ; and the potential of the air between B and C is then rendered uniform [or, commonly speaking, the potentials of B and C are equalised] by making one of the liquids drip inside a cavity kept moist with the other. A and C are connected by platinum electrodes through a compensation resistance-box and battery to a quadrant-electrometer, and the difference of potential between them measured. The arrangement is highly ingenious, but the difficulties of definite and certain measurement must be considerable.

The same physicists have quite recently made a determination, not of the Volta-effect, but of the true contact-force between two liquids, by the use of mercury electrodes ; employing for this purpose a theorem of Helmholtz, that if by judicious polarisation the capillary constant of a mercury-liquid surface be made a maximum, then between the mercury and the liquid there is no difference of potential.*

Their account of this last determination has not yet been published, but it will appear shortly (before this is printed probably) in the *Comptes Rendus*.

The theorem gives evidently an admirably simple method of measuring liquid / liquid contact-force, if it can be made to work practically.

MM. Bichat and Blondlot apparently hope, by a comparison of the two methods, the results of which are quite different (in accordance with the views expressed in the present communication), to be able to obtain values for air / liquid contacts. This would be a most important and useful piece of work : the only difficulty in accomplishing it is the difficulty of getting both sets of measurements thoroughly dependable. I hope they may succeed in overcoming all obstacles.

(TO BE CONTINUED.)

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.

Prof. Oliver Lodge's paper on the Seat of Electromotive Force in a Voltaic Cell, read at the preceding meeting, was discussed by the members of this society on Thursday, 23rd ult. Prof. PERRY opened the debate. Remarking first that Prof. Lodge had given rein to his speculative predilections, and had taken too little heed of the observed facts connected with the subject, he proceeded to say that the point in dispute was practically one of Maxwell *versus* Thomson. All the evidence afforded by past experiments since the time of Volta pointed to the conclusions generally accepted until now, and Dr. Lodge ought to furnish very strong reasons for abandoning those conclusions. He had given none of an experimental kind, and had simply contented himself with proving, as he thought, the absurdity of the commonly-received theory. The paper had been misnamed ; it was really an attack on the contact theory. On this Prof. Perry was understood to say that strong evidence existed to show there was a difference of potential between zinc and copper in contact, but that Prof. Ayrton and he had never stated that the electromotive force was at the point of contact. Dr. Lodge had contended that if the observed phenomena resulting from contact were due to contact only, there must be some external supply of energy. Prof. Perry did not see this necessity, and suggested an internal action due to what might be termed tension energy. This he illustrated by reference to weight at the end of a rope raised by an engine. But he preferred an hydraulic analogy, the tendency of electricity to leave copper and enter

* *Monatsberichte der Berliner Akad.* November 3, 1881.

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zinc, which is called contact force, corresponding with the difference of level in water. He maintained that conclusive experiments had shown there was a difference of potential at the junction of two metals, although the electromotive force was due to chemical action.

Prof. CAREY FOSTER expressed his opinion that Dr. Lodge had given a more satisfactory explanation of the phenomena than any that had gone before, namely, that the E.M.F. comes in where the chemical action takes place ; and that if Dr. Lodge's propositions proved to be correct they would certainly upset the contact theory.

Dr. HOPKINSON thought that this was mainly, after all, a question of definition ; but that Dr. Lodge's would be found the most convenient, as it actually does account for all the known facts, and was, therefore, a better working theory than the old one, which does not. He suggested certain experiments by way of deciding the matters in dispute.

Dr. FLEMING spoke in similar terms.

Prof. FORBES, who read a short communication not very relevant to the question from Sir W. Thomson, was of opinion that the contact theory was as good as any other to work with, and he thought it better than Dr. Lodge's new theory.

Prof. AYRTON described some experiments made in 1878 with bodies at different temperatures, the results of which wholly supported the contact theory. He suggested the probability of electricity residing in the zinc and in the copper, and the possibility of their differing in electrical condition when brought in contact.

Mr. SWINBURNE offered evidence to show that neither of the theories under discussion satisfactorily explained the phenomena, and entered upon a detailed examination of Dr. Lodge's statements ; but as the hour was getting late Mr. Swinburne reserved his remarks for a separate communication to the society.

Prof. SILVANUS THOMPSON, at the invitation of the President, made a brief statement to the effect that no conclusive experiment had ever yet been made establishing the contact theory ; whilst those that had been made were open to precisely the same objection as those which are urged against the conclusions drawn from Mr. Brown's experiments with metals in different gases.

Prof. AYRTON replied that this was not the case, for Mr. Brown's arrangement could not be built up into a series, as in the case of a Daniell cell.

To this Prof. S. THOMPSON rejoined that it could ; and that if anybody had failed it was because they had not gone the right way to work. The difference of potential must inevitably give the E.M.F. if the requisite conditions are complied with in gases as well as in air.

Dr. LODGE replied very fully and with ample illustrations on the black board to the criticisms, chiefly of Profs. Ayrton and Perry ; but as his remarks, although of great interest and delivered with his accustomed felicity and humour, went to reaffirm the salient propositions of his original paper, they need not be reported at greater length here.

A cordial vote of thanks, proposed by the president, Mr. SPAGNOLETTI, was accorded to Dr. LODGE, and the proceedings terminated at an unusually late hour.

PHYSICAL SOCIETY.

At a meeting of this society, held on 25th April, Prof. Guthrie, president, in the chair, the following papers were read :—"On the Theory of Illumination in a Fog," by Lord Rayleigh. The paper dealt with certain theoretical results based upon the assumption that the medium in which the fog was formed, and the substance composing the fog itself, were perfectly transparent. The effect of such a fog surrounding a source of radiation would be to diminish the radiation, and in the case of a supply of energy from without, as with the carbon filament of an incandescent lamp, the temperature of the source would be increased by the fog. A spherical envelope of such a fog surrounding the lamp, and sufficiently thick to be impervious, would act as a perfectly reflecting surface. A problem closely related to the above, and which is easily worked out, is that of light incident normally upon a pile of glass plates. If m be the number of such plates, and ρ the fraction of incident light reflected by one plate, $\phi(m)$ the light reflected, and $\psi(m)$ that transmitted by a pile of m plates, we have

$$\frac{\phi(m)}{2m\rho} = \frac{1}{1+(2m-1)\rho} = \frac{\psi(m)}{1-\rho}.$$

If the transmitted light be allowed to fall upon another pile, consisting of n plates, we have an infinite amount of reflection between the plates, and as the final result, if A denotes the radiation in the original direction, and B that in the opposite,

$$A = \frac{2n\rho+1-\rho}{2(m+n)} \qquad B = \frac{2n\rho}{2(m+n)\rho+1}.$$

If m and n are large, we have $A = B = \frac{n}{m+n}$, which shows that by increasing n we can make the radiation between the plates as much as if the first pile did not exist, whatever the number of plates in it.

"On a Monochromatic Telescope," by Lord Rayleigh, followed by "On the Self-Regulation of the Compound Dynamo," by Prof. A. W. Rücker. If ϕ represents the current or electromotive force in the external circuit of either form of compound dynamo, it is given by means of an equation of the form

$$\phi = \frac{P}{A+x} - \frac{Q}{B+x},$$

where A, B, P, and Q are quantities which are different in different cases, but are always independent of the external resistance, and x is the conductivity or the resistance of the external circuit, according as ϕ represents the E.M.F., or current. The constant A in all cases depends only on the resistance of the various parts of the machine.

If μ and m are respectively the largest and smallest values of x between which self-regulation is aimed at, then $\mu - m$ may be called the *range* of x. That value of x which corresponds to the resistance most frequently used may be called the *usual value* of x, and indicated by ξ.

The maximum efficiency, η, of the machine is connected with A and ξ by the relations

$$A = \xi(1+\eta)/(1-\eta), \text{ if } \phi \text{ be the external E.M.F.}$$
$$A = \xi(1-\eta)/(1+\eta), \text{ if } \phi \text{ be the external current.}$$

It can easily be shown that the function ϕ has two critical values, and that the value of x corresponding to one of these is necessarily negative unless one of the inducing spirals is wound so as to diminish the magnetisation.

Various cases are considered corresponding to different relations among the magnitudes of the constants A, B, P, and Q. The following indications of the method of treatment may suffice:—If $A/B < 1 < \sqrt{P}/\sqrt{Q}$, ϕ is positive for all positive values of x, and the critical value of ϕ occurs for a negative value of x, so that ϕ diminishes as x increases. Hence, if we write

$$\frac{P}{A+m} - \frac{Q}{B+m} = \phi_1$$

we must have

$$\frac{P}{A+\mu} - \frac{Q}{B+\mu} = \frac{\phi_1}{1+q},$$

where q is a positive quantity which will be less as the self-regulation is more perfect. These equations give

$$P = \frac{\phi_1}{1+q} \cdot \frac{\mu - m - q(B+m)}{(A-B)(\mu-m)} (A+\mu)(A+m)$$

$$Q = \frac{\phi_1}{1+q} \cdot \frac{\mu - m - q(A+m)}{(A-B)(\mu-m)} (B+\mu)(B+m).$$

Now, since A − B is negative, we must, if P and Q are positive, have

$$q > (\mu - m)/(A+m)$$

and *a fortiori*

$$q > (\mu - m)/(B+m)$$

By similar methods inferior limits to q are found in other cases, and it is thus shown that for given values of μ and m the limit is lower as A is larger. It has, however, been proved above that if the maximum efficiency of the machine is high, A will be large or small according as it is taken from an expression that gives the external E.M.F. or the external current. Hence it is more difficult to combine high efficiency with good self-regulation if an approximately constant external current is desired than if an approximately constant external E.M.F. is aimed at. The equations do not lead to any simple rules for the relations which should hold between the various parts of compound dynamos ; but if some of the constants are taken as given, the values which must be assigned to the others can be calculated if a given efficiency for the usual value of x, and a given deviation from perfect self-regulation between given values of x are to be attained.

A "Paper on the Determination of the Heat Capacity of a Thermometer," by Mr. J. W. Clarke, brought the proceedings to a close.

THE INTERNATIONAL INVENTIONS EXHIBITION.

The whole of the lighting of the buildings and the illumination of the garden and the terraces at the Inventions Exhibition this year will be carried out by means of the electric light. In 1883-4, there were 252 arc lights and 2,629 incandescent lamps used ; this year there will be 464 arcs, and 5,530 incandescent lamps, without taking into account many thousands of crystal lights. The number of exhibitors of systems of lighting, 21 in all, is the same as at the Health Exhibition, but eight new names appear in the list, filling the places of companies defunct or of firms who from various causes are not among the competitors. The illumination is equal to that of nearly 533,000 candles, the distribution being more exactly reckoned at 108,800 candles for the 5,530 glow lamps, and 424,150 candles for the 464 arc lights. The latter vary from 200 candle-power per lamp of 70 Varley lights, to be placed in the Eastern Arcade and Western Avenue by Messrs. Gaulard and Gibbs, to 5,500 candle-power each for four brilliant Siemens lights in the Conservatory. The highest estimated power for incandescent lights is that of 50 candles per lamp of 250 Bernstein lamps, shown by Messrs. Paterson and Cooper in the dining rooms. Of the Gulcher lamps, 200 exhibited by the Gülcher Electric Light Company in the Chinese restaurant and 250 of the Woodhouse and Rawson lamps are only to be worked to 16 candle-power per lamp. In the "Old London" Street there are five Lea lamps of 2,500 candle-power each, so arranged as to produce the picturesque effect of moonlight in the street and narrow lanes, while the shops and rooms upstairs are lit with 300 incandescent lamps by Messrs. R. E. Crompton and Co., on two dynamos supplied by a 45 horse-

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power Willans high-speed engine. In the Prince of Wales's Pavilion there are 200 Swan lamps from one dynamo run by a 30 horse-power Elwell-Parker high-speed engine. The Water Pavilion has 250 crystal lamps exhibited by Messrs. Goolden and Trotter. Messrs. Siemens again light the Middle South Court, with 1,080 Swan lamps, of which the light is estimated to be equal to that of 21,600 candles. The new court, contiguous to this, and of equal width, is illuminated by the Anglo-American Brush Electric Light Corporation with 1,000 Victoria incandescent lamps, from three dynamos run by a Kitson-Parsons high-speed engine of 150 horse-power. The new court opening to the left of the entrance to the Central South Court, and occupying the place of the first class refreshment rooms, is supplied by the Edison Swan Company with 1,000 of their own lamps, from dynamos served by a Mather and Platt high-speed engine of 190 horse-power; this company's lamps are also fitted in the subway. Messrs. Clark and Chapman light the grill room with 100 glow lamps, on two dynamos worked by one of their high-speed motor engines of 15 horse-power. The lighting of the aquarium is entrusted to the Gülcher Electric Light Company, who use 800 glow lamps, computed to be worked up to 20 candle-power by two dynamos served by a high-speed Coalbrookdale engine of 120 horse-power. The greatest number of arc lights in any one building will be found in the enlarged east gallery, where Messrs. Thompson, Houston, and Co., exhibit 45 lamps of 1,000 candle-power, and 18 of 600 candle-power each. The south middle gallery has 60 Jablochkoff lamps of 400 candles each; the central gallery takes 50 Gülcher lamps of 1,000 candles each, on dynamos worked by a Westinghouse high-speed engine of 120 horse-power; and the Queen's Gate Annexe (where the Belgian exhibits were placed last year) has 24 Brush lights of 3,000 candles each. Distributed in other parts of the exhibition there are 24 Sun lamps of 1,100 candles; 42 Pilsen lights of 750 candles; and, of the same power per lamp, 16 sent by Messrs. Paterson and Cooper; 24 by Messrs. Cordner, Allen, and Co.; 10 Cardon and 10 Werner, exhibited by Messrs. Clark, Muirhead, and Co.; eight Sennett lamps of 2,500 candle-power each; and 14 Bowman lamps of 700 candle-power, shown by Messrs. Clarke and Bowman. In the gardens six Hochhausen lamps of 3,000 candles are displayed at the mast head by Messrs. Goolden and Trotter; Sir Francis Bolton will employ 12 Siemens lamps, each of 3,000 candle-power, in the illumination of the fountains; and lastly, in the electric light shed 16 Andrewes lights of 800 candles per lamp are used.

REPORT ON ELECTRIC LIGHTING IN THE CITY.

(CONCLUDED FROM PAGE 499.)

6. DOMESTIC LIGHTING.—As our experience of domestic lighting in England is so limited, owing to the expense and difficulty in getting our houses supplied with the requisite power and fitted up with the necessary appliances, I determined to fit up my own house, to enable me to acquire personally the requisite knowledge of the cost and trouble likely to arise in maintaining such an installation. All estimates and calculations of cost, though honest, are unreliable. Figures are so easy to manipulate, and prejudice can so simply exclude or admit essential matters. Facts and real practice are alone reliable. It was not, however, so much to determine the cost, as it was to find out the reliability, to discover the faults, the troubles, the nuisances, or otherwise the amount of supervision necessary to keep the light going, and generally to learn the possibility of my untechnical neighbours being able to indulge in the luxury of the electric light. Accordingly, I built in my garden a small engine house, sixteen feet by ten feet. In this house was fixed a 2 horse-power Clerk gas engine, manufactured by L. Sterne and Co., of Glasgow. This drives a small dynamo-machine, manufactured by Messrs. Elwell and Parker, of Wolverhampton, whose current charges up seventeen Planté's secondary cells, supplied by the same firm. The dynamo develops a very steady current of 42 volts and 36 amperes, which is equivalent to 1·512 watts, or a little over 2 horse-power. The secondary cells are connected directly to the house by means of copper mains insulated with india rubber, as supplied by the India Rubber, Gutta Percha, and Telegraph Works Company, the same kind of wire, but smaller, being used everywhere for the mains and sub-mains. The switch and lamp leads are of No. 18 copper wire, insulated with gutta percha, having a double layer of cotton braided together into a neat twine, the whole being well paraffined, and supplied by Messrs. W. T. Glover and Co., of Manchester. The lamp fittings are supplied principally by Mr. Tayler Smith, and are of that movable character peculiar to that gentleman's system, and rendered familiar by his well-known exhibit at the International Health Exhibition. The lamps are 31-volt lamps, manufactured by Messrs. Woodhouse and Rawson, which, when worked with a current of ·92 ampere and an electromotive force of 33·4 volts, develop an illuminating power of 10 candles, and give an efficiency of 3·5 watts per candle. Each room has its own circuit, controlled by a switch in the central hall, and protected by a safety cut out. Every fixed lamp has a switch to put it in or out of circuit at will. This is unnecessary for the movable lamps. The engine room has a Cardew voltmeter, to determine the electrical pressure and condition of the batteries, and a simple galvanometer to determine the current flowing into or out of the batteries; a galvanometer is also fixed below the main switch in the hall, to see what number of lamps are burning in the house, to detect any that may be left improperly turned on, and to test the condition of the circuits. There is a constant supply of electricity in the house, and the lights can be turned on and off at any hour of the day or night. The engine room is under the charge of my gardener, who has had no difficulty or trouble whatever in mastering the details of the apparatus, and who attends to everything without materially interfering with his proper duties. He simply lights the gas and sets the engine going. If anything goes wrong an automatically-worked outdoor electric bell attracts his attention to it. When the engine has run the necessary number of hours, he stops it. I have not studied economy. I have been anxious to secure efficiency, and to do everything that was necessary to thoroughly illuminate with safety and simplicity, and without show, a small house like my own. Hence my expenditure at present is no criterion of what it ought to be. I have had to surmount many difficulties and to make many changes, in order to meet my requirements, but I have at last satisfied myself that my installation is practical. I have also been experimenting so much that my consumption of gas is no criterion of what it ought to be. Nevertheless my consumption of gas has been no more than it was during the corresponding quarter last year. My installation has not been going on long enough to enable any accurate estimates to be formed, but I will keep careful record of what is done, and after twelve months' working I will publish the results. I have formed the following conclusions:—1. That electric lighting, when obtained by an isolated plant such as mine, is a luxury that must be paid for as a luxury. I could not with my present experience fit up my house for less than £300, or, say £7 10s. per lamp; but of course this will vary with the artistic taste and character of workmanship displayed in the fittings. 2. I ought not to consume more gas for power than I have hitherto done for light. Indeed, I think I shall consume less. I can say that my house is still lighted by gas, but I now consume my gas in my garden, and not in the house, extracting from it that which I want—*light*—and discharging into the external air that which I do not want—*poison*. Hence I have filtered my light, and purified the air I breathe. 3. The steadiness, charm, and comfort of the light, the durability of my decorations, the absence of heat and of all destructive gases, the nonvitiation of the air of my rooms, and the longer life one gains in consequence, make up a splendid dividend on the capital I have invested. 4. It is idle to deny that there are many difficulties that yet exist to be surmounted, and that can be overcome only by technical skill and experience; but this experience is being rapidly gained, and this technical skill is coming within the reach of all. Anyone with ordinary intelligence and scientific tastes, can have no difficulty in mastering all the details, but electric lighting has not yet reached the simplicity stage of gas. 5. One important item of economy in electric lighting is this, that one need expend energy in light only when and where it is wanted. When gas is used a servant goes round and ignites the gas jets, and they are left for hours to waste away unnecessarily and expensively, whereas with electricity a switch near the door or on the lamp enables one to produce a flood of light only during the time it is wanted, and without a match or taper. Hence if electricity costs twice or thrice that of gas it need be expended only one-half or one-third the time. 6. By the use of such a low pressure as 31 volts, no shocks are possible, nor is there any fear of fire or damage to insulation. Matches and candles are rendered unnecessary, and therefore the security from fire is immensely enhanced. 7. All the trouble and difficulties that I have encountered will be entirely eliminated when electricity can be supplied at our doors as gas is now. They would also be very much reduced if the installation were large enough to justify the employment of a technical hand to look after it. But before electric lighting can be general, the economical distribution of electricity from central points is imperative.

7. CENTRAL STATION LIGHTING.—If electricity could be supplied at our doors in the way prescribed by the Act of 1882, so that we should have a constant service at a constant pressure, all the difficulties that I have experienced in producing my currents in my own house would disappear. Electric lighting would become general—every one would have it if the price were reasonable. But the difficulties and cost involved in distributing the electricity at present are so great that there is not a single central station at work in London. The mechanical and electrical difficulties are being surmounted, but the financial difficulties remain. The Act of 1882 renders it impossible for any company to be formed to carry out the provisions of the Act. Its restrictions are so rigid that it has entirely checked electrical lighting by private enterprise. Of the 73 Provisional Orders obtained in 1883, not one has been persevered with. The only installation that has been carried out under the Act is that at Colchester, and that is done by a company which has a small unexpended capital. Electrical lighting on a large scale means a very large capital expenditure. This capital can now be raised only by the Corporations concerned and on the security of the rates. The Act is of no use for the purpose for which it was passed, and it is questionable whether a local authority like the Commissioners of Sewers of the City of London need regard the Act at all should it determine on establishing an electric lighting system. This, however, is a legal question on which I am not competent to express an opinion. Assuming that it were decided to light up a portion of the City as a tentative measure, the all-important question of the distribution of electricity is a very knotty point indeed to decide. I must confess that I am not convinced as to which is the best system, and without further experience and careful examination I should hesitate to recommend either of the systems I have described as being the best. Indeed, the room for invention in this direction is so extensive, that it may happen that in a short time some plan more perfect and still more economical may be introduced. I intend during my forthcoming visit to America to give this matter the most careful study, and, with the experience gained in Colchester, I trust at the end of the year to be in a position to select a definite system for recommendation. In a report made to the Streets Committee on the 2nd November, 1882, I made the following remark:—"The whole question of the distribution of electricity for lighting purposes is in a very tentative state; sufficient experience has not yet been gained to determine exactly what is required under all circumstances, or even what those circumstances will be, and I think that those corporations who have taken upon themselves to supply electricity have undertaken a responsibility that they have not sufficiently contemplated, and which, with the present state of our knowledge, is extremely difficult

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to discharge." I venture to remind the committee of the truth of this, and to assert that at the present moment it is still to a great extent the state of the case—electric lighting is unquestionably a great success, but the best means of developing it economically and practically, on an extended scale, have yet to be decided. To attempt to light up a large area with our present experience, and in face of an objectionable Act of Parliament, would be unjustifiable, but to take a small area as a tentative measure, would be a wise and proper course to adopt, and it is that which I very strongly urge the committee to agree to.

8. STREET LIGHTING.—The lamp which, in my judgment, best lends itself to street lighting is the glow lamp, and of the glow lamps I prefer the 50 candle lamp for the main thoroughfares. It was very successfully employed on the Holborn Viaduct, where there were sixteen 16 candle-power (nominal) lamps and seventy-six 32 candle-power (nominal) lamps. No more perfect specimen of street lighting was ever seen than the experimental illumination of the High-street, Wimbledon. The lamps were fixed over the centre of the road. They had not the captivating brilliancy of the arc lamp, but their light was evenly distributed and there was no waste. There would, I fear, be great difficulties in suspending lamps over the centre of the roadway in the City, owing to the requirements of the Fire Brigade, whose escapes require a headway of 35ft., but an admirable effect would still be obtained by fixing these lamps on posts on the curbstone, as at present, and 50ft. apart. I should much like the Streets Committee to select a main thoroughfare, and allow the experiment to be tried. Whatever difficulties there may be in introducing domestic electric lighting cease altogether when we regard street lighting. There is no difficulty in distributing the current; the whole of the streets of the City could be illuminated from one centre; the lights could be turned on and off in one second; and if the power required to produce the currents were obtained from gas engines, then on the approach of fogs the streets could be instantaneously lighted without sending round any lamplighter.

THE COMMITTEE ON OVERHEAD WIRES.

The Select Committee of the House of Commons resumed their inquiry again on Thursday, Mr. G. Russell presiding.

The first witness for the day was Mr. PILDITCH, surveyor to the Wandsworth Local Board. In the course of his examination he stated that in 1884 a telephone company sought to fix certain wires in the Wandsworth district, and on the Local Board resisting that a case was submitted to Mr. Justice Stephen, who gave judgment in favour of the Board. Subsequently that decision was reversed, with the result that the Company were left free to fix wires without restriction. The Board now felt that some restrictions should be placed upon telephone companies; that the local authorities should have the right of granting licences, and should also have absolute power to decide whether wires should be laid under or over ground, without any appeal. Numerous accidents had occurred in this district, one having had a fatal result, while several others nearly proved fatal. The Board would rather all the wires were underground, but if it was absolutely necessary to allow them to pass over houses, that at least should not be permitted without the supervision of the local authorities. His Board held that wires generally should not be fixed without due notice to them, and that they should then have control as to the height, length, strain, and other points connected in fixing wires. Several of the Post Office wires had broken. There were very many wires in his district, but he could not say to whom they all belonged, for they were often fixed at night or in the early morning without the knowledge or consent of the people in the houses. He had heard many complaints on that ground, but no formal written complaint had been made to the Board. For such cases people had a legal remedy, but very few knew what their legal powers were. The Post Office fixed wires in that way, but he could not give an instance of a telephone company doing so, though both fixed wires pretty much as they pleased.

Mr. GRAY, addressing the Chairman, said he thought some technical evidence ought to be called upon the question of twisting mentioned by the witness, as this was a point of great importance.

Mr. ALLISON, city surveyor of Manchester, the next witness, informed the committee that during the last three or four years there had been a great increase of wires in Manchester, and although he would not go so far as to say all wires ought to be placed underground, he was in favour generally of that system. In Manchester there had been several accidents through wires breaking. The Corporation spent £50,000 annually in widening and opening up streets, and they consider it unfair that telephone companies and telegraph companies should be allowed to fix wires overhead in an unsightly manner. Wires fixed diagonally across streets were very objectionable, and at least they ought to be fixed at right angles. He believed the average duration of a wire in his district would be from four to five years. Where overhead wires were permitted, provision should be made for their removal if necessary as interfering with property or if otherwise objectionable, and there ought also to be a minimum height of 40ft. fixed to enable fire-escapes to pass under. He would allow no right to be acquired by the owner of wires through user or lapse of time, and he would require every wire to be registered in order to fix the ownership and liability. The Corporation had obtained an Act enabling them to frame bye-laws, but they had not put it in force, because they wished first to gain experience. The Act was therefore practically a dead letter, and they had not carried out the inspections they were empowered to make. He would place the Post Office under the same restrictions as the telephone companies, for although most of their wires were underground they might change their system. They had not put their Act in force, because the telephone enterprise was in its infancy, and they did not wish to check or suppress so useful a system. They were perfectly satisfied with the powers their Act gave them as to bye-laws, but they ought to have the control of the wires. They did not wish for power to compel wires being put underground, but they had power at the end of five years to require a wire to be put underground on paying one-third of the cost themselves. They further thought there should be an appeal to the Board of Trade in regard to bye-laws, as it was important to have something like uniformity of bye-lays. He would give telephone companies a right to be heard before the Board of Trade against any bye-laws submitted; but the Corporation would not be prepared to hand over their right of making bye-laws to the Board of Trade, though they would be willing to submit them for approval. A fatal accident had been caused through a wire being two low—only about 25ft. above the street. He thought it would be practicable to make subways for wires under the footpaths in Manchester—at least, for the main trunk lines. No doubt an underground wire would cost more than one overhead, but if a number of underground wires were run together the expense would not be very much greater. The Corporation of Manchester were satisfied with the powers the Act gave them, but they were now realising that they must take some action. They did not wish to strangle the enterprise, but they felt they must have some of the wires put underground.

Mr. DUNSCOMBE, city engineer and borough surveyor of Liverpool, stated that the Corporation of Liverpool had also obtained an Act for framing bye-laws to regulate telegraph and telephone wires. They had framed such bye-laws, and they considered their powers sufficient to protect the public; and on the whole, they thought there was practically no greater danger from overhead wires than from underground wires, if the former were properly put up. They never allowed posts to be erected on the public highways, and as a rule the wires were carried over the house-tops. It was very important in such a city as Liverpool not to increase the necessity for opening the streets, and already great incovenience arose from the power of the Post Office and the gas and water companies to open the streets. The telephone had become a business necessity, and in the opinion of his Corporation every reasonable facility should be afforded for its development, consistently with public safety and convenience. Any large expenditure in carrying lines in iron pipes underground would have to be defrayed by the general public using the lines, and that in many cases would so increase the charges as to render them prohibitory. The cost of subways would have to be borne in the first instance by the local authorities, and for many years the system would be unremunerative, and in Liverpool the sewer system would make the construction of subways very difficult and so costly as to be prohibitive. Mr. Dunscombe insisted that the Corporation must be the authority to make bye-laws, subject to the approval of the Board of Trade, and with a right to the companies to be heard.

Mr. LAWES, C.E., President of the Association of Municipal Engineers, and City Engineer and Town Surveyor of Newcastle-on-Tyne, stated that the members of the Corporation had, with one or two exceptions, uniformly insisted upon telephone and telegraph wires being placed underground. Within the business area of the town they had not relaxed that rule except in one case, but in the thinly populated districts they had allowed wires to be hung from posts. In the exception mentioned leave was given to the Northern District Telephone Company to carry their wires over the Close, which ran parallel with the river, and in which the buildings were intercepted by "chairs" (or passages). In that case there would have been hardship in insisting upon underground wires, and therefore the exception had been allowed. The Corporation had resolved to have telephone and telegraph wires underground through observing the great growth of these wires in other large towns and through fear that these wires would become a source of danger, as they had become in Manchester, Liverpool and other cities. There were some overhead wires in use in Newcastle, but they were so few that they would hardly attract any notice. They had had no accidents, and although the use of the telephone was rapidly spreading they were still able to meet the increase by the underground method. He had communicated by telephone up to ten miles (that was to Sunderland) under the existing system, and he had found the communication distinct and perfectly satisfactory. In fact, the working of this underground system was very satisfactory. He had heard that some of the witnesses had said there were scientific difficulties likely to make an underground system impracticable, but in Newcastle the system was complete and perfectly practicable. As to the question of prohibitory cost, there were 500 members of the telephone exchange in Newcastle, and he had no reason to suppose that the telephone would have been more widely extended if the wires had been carried overhead. Indeed he did not suppose the charges would be reduced if the wires were taken overhead, and he did not believe the action of the Corporation had impeded the development of the telephone. Certainly that would be the last thing they would wish to do. The Corporation had had some transactions with the Post Office, and had always found it easy to work with that Department. The wires were laid in iron pipes placed under the footway, and the operation of placing them was very quickly done. He was afraid a system of large subways, such as had been suggested by some of the witnesses, would be impracticable in Newcastle for many reasons. The Corporation had no special legislative powers relating to telephones, but by virtue of Crown grants in the past they were the owners of the streets, as well as the sanitary authority, and so had at present sufficient safeguards. They did not now wish for extended powers, but in the event of fresh legislation they would wish to be placed in a good position in regard to the control of these wires. In the view of the Corporation, they ought to have general powers to make bye-laws, subject to the sanction of the Board of Trade, and control the wires; but they did not desire any absolute powers, except to prohibit overhead wires. Both the Post Office and the telephone companies had wires under the flags, and in some cases, probably, under the same flags. The branch wires diverged

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from the main lines in the same way as gas and water pipes were led into houses.

Mr. HORN, of the Westminster Vestry, said he was one of the three witnesses appointed to represent thirteen of the metropolitan vestries. They had frequently considered the subject of overhead wires, and they thought the time had come when it was necessary that Parliament should deal with it. They were of opinion that in any legislation that might be introduced it would be desirable, in the interests of the public, that as a general principle all telephone and telegraph wires should be placed underground—or at least all the main trunk lines and heavy branch lines. As a practical engineer he saw no real difficulies, and as to the cost of underground wires, he thought it had been very much exaggerated. Underground wires might be more expensive at the outset, but they would be more endurable, and in the end cheaper than overhead wires. He regarded the present system as merely temporary by way of experiment. There was great risk of danger from the overhead wires, and many had been reported to have fallen. A few weeks ago it was reported that many hundred wires had fallen during a storm, and he believed that if there had been a severe frost then instead of a thaw the great bulk of the wires would have come down. The vestries held that the public ought not to be exposed to this danger, and they were unanimously of opinion that the control of the wires should be in the hands of the respective vestries and local boards; in the same way as gas and water pipes and telegraph wires were. In the event of a dispute between the vestries in London, or between a vestry and a company, an appeal should be made to the Metropolitan Board of Works, and to the Board of Trade if a vestry could not agree with the Post Office. Certainly where a wire was to be erected overhead the district authority ought to have control, with a power of inspection, but he would not give the Boards an absolute veto.

The committee then adjourned.

On Monday last another sitting of the committee was held under the presidency of Mr. G. W. Russell. The first witness examined was

Sir J. BAZALGETTE, the engineer to the Board of Works, who said that the system of wires in the metropolis was introduced twenty years ago. There was very rarely any overground, and none underground, before that time. During the twenty years that these wires had been in existence the increase had been very rapid. He estimated that there were 800 miles of overhead wires, and ten times that number of underground wires. These wires were subject to the local authorities only when they interfered with the roadway. He knew generally that there had been accidents, but not to a very large extent, and he did not think that what had taken place was any basis for the future. He had no idea of the duration or life of a wire. The Board of Works was a suitable body for controlling the wires, for they had ample machinery which could very readily be applied to that work. The Board of Works might make the bye-laws for the metropolis, and he did not think there would be any advantage in giving an appeal or veto to a Government department. At the same time, private owners would have sufficient protection in the Board of Works, on which they were represented, and then he would give the Board final power, and not allow owners to have a veto, because, if they had a veto, the public safety might be endangered. But, while the Board had a compulsory power, owners should be entitled to pecuniary compensation; and it would be well to require a nominal payment to an owner to prevent a right accruing from user. The Board of Works should make the bye-laws, but the local authorities should be left to see them carried out, and local authorities should also have a right to be heard against any bye-laws laid down. As to the whole of the United Kingdom he thought there should be some limit to the principle of central control, and he believed the question of damage through entering premises could be settled by the local authorities.

Mr. JANSEN, solicitor, next gave evidence on behalf of a number of solicitors and agents representing the Duke of Bedford, the Marquis of Salisbury, Earl Cadogan, several City companies, Guy's, St. Thomas's, and Christ's Hospitals, and a number of very large property owners in London. He explained that, as the manager of the Pollen Estate, his attention had been drawn to the question of wires erected over houses, and from posts, without permission, and he invited a number of the managers and solicitors to meet and consider the subject. They instituted an inquiry, and finding that so many wires had been put up without consent, they served notices on the United Telephone Company to remove the wires. This the company met by giving them an acknowledgment that all of their wires so erected existed only on sufference. A similar acknowledgment had been given to the Duke of Westminster. At their meeting the representatives passed resolutions in favour of greater control over, and a complete registration of these wires, the latter in order to ascertain the ownership of wires, and to prevent wires being put up surreptitiously. Since then they had also come to a conclusion that the sanction of local authorities should be necessary to the fixing of fresh wires, and that wires should be under the control and supervision of the local authorities, with an appeal to the Board of Trade, Local Government Board, or Metropolitan Board of Works. They very much preferred that wires should be laid underground, partly because of public safety and partly because of the unsightliness of overhead wires, and the consequent injury to property. He and those he represented held that the assent of both landlord and occupier ought to be obtained for merely running a wire over a house, and *a fortiori* for making attachments. The telephone was no doubt a great convenience, but he could not regard it as a necessity, and the existence of the telegraphs made the necessity still less.

Mr. PREECE, electrician to the Post Office, was called to give the results of his experience of telephones in America. He said he visited the States in 1877, and brought over the first telephonic instrument that was ever practically used here. At that time there was only one telephone exchange open in America, and the wires were invariably overground; but there had been an enormous development of the telephone as compared with its progress here. In New York and its neighbourhood alone there were more telephone subscribers than there were in the whole of this country, and in Chicago, Baltimore, Boston, and Philadelphia, and other towns there were from 1,000 to 2,000 subscribers. Without exception all the wires were carried overhead, and across the Broadway, New York, there were six distinct lines of poles carrying overhead wires. These poles were fixed in the kerbs, and the result was that the streets were ruined and disfigured in appearance. There had been great outcry there against the wires, but only on the ground of disfigurement and obstruction, and not on public danger. Many of the local legislatures had passed Acts for compelling both telegraph and telephone wires to be put underground, but in no case had this been carried out, for the companies in America did not like to be driven, and their reply was that if they were shown a practical way of working an underground system they would adopt it, unless it was too expensive. He had heard of three or four cases of fire having been caused through electric light currents getting in contact with telegraph and telephone wires, and so diverting the strong currents into an office, and setting fire to the place. In consequence of these fires the electric light companies had adopted a special electro-magnetic "cut-out," which came into operation immediately an electric light current entered a telephone or telegraph wire. Mr. Preece attributed the greater growth of the telephone in America mainly to a higher appreciation of it by the people than was shown here, and stated that, while in one system the cost was equivalent to £42 a year, the general cost was equal to £30 or £35 a year, adding, however, that the telephones and other wires in America were heavily taxed as a source of revenue. There was no scientific difficulty in having an underground system, but there was a practical difficulty. For telegraph purposes an underground system tended to diminish the speed of working and of carrying capacity, and as to telephones the same influence removed the clearness of articulation of speech, and at a certain distance speech became practically impossible along an underground wire. Mr. Preece said he had gone very thoroughly into the circumstances of the Battersea wire case, referred to by a previous witness, and he had come to the conclusion that the only possible means by which that wire could have become so twisted round the lamp post was by its having been rolled round the post by passers-by.

Mr. PATEY, one of the secretaries to the Post Office, being briefly examined, said the Post Office still adhered to the opinions previously expressed as to alterations in the present law, and added that it was very doubtful whether any system of inspection would be useful, because it would tend to remove from the Post Office or telephone officials their sense of responsibility in the case of the wires, and they were most competent, through their constant experience, to properly maintain the wires in safe condition.

Sir GEORGE CAMPBELL, M.P., tendered evidence as a "typical householder," and described the grievance he felt respecting the present state of things. He had, he stated, determined from the first that he would give no authority for placing wires on or over his house in Gloucester-road, feeling that that ought not to be done without the consent and control of the local authority. Wires had, nevertheless, been carried over and attached to his house, by whom and when he could not ascertain. The first wire came he knew not whence, and went he could not tell where—passing from one invisible distance to another invisible distance. During the recent storms the first wire had come loose, and although he gave strict orders to his servants not to allow anyone to go on the roof to repair the wire without explaining who he was, the wire had been mysteriously put up again, and another wire also attached to his side of a parti-chimney stack. Every wire should be registered, and a plan of an intended wire furnished to the local authority, who would then decide whether to grant a license or not.

The committee then adjourned to the 11th inst.

LEGAL:

Irish v. Northern District Telephone Company.

In this case, which came before Mr. Justice Grove, William Edward Irish, an electrician, sought to recover from the Northern District Telephone Company a sum amounting to nearly £100, alleged to be due on certain royalties payable in respect of the use of a patent switch-board, of which the plaintiff is the inventor.

Mr. Lockwood, Q.C., and Mr. Robins were for the plaintiff; Mr. Gates, Q.C., and Mr. Meek, for the defendants.

It appeared that before Mr. Irish had actually obtained the letters patent he entered into an agreement, dated 16th March, 1882, with the company, of which he had been formerly a director, by which he sold them four of the switch-boards he had manufactured, for £250, each board connecting 50 subscribers' wires. The agreement also contained the following clause:—"That within fourteen days of when such letters patent shall be granted the vendor shall execute to the purchasers an assignment thereof, on payment of a rent or royalty in respect of the switch-board to the vendor of 2s. 6d. per every subscriber's wire any such switch-board is made to connect." Upon that clause the plaintiff now sued for the 2s. 6d. per every wire on those four boards. The defendants contended that they had bought the switch-boards out and out, and were therefore entitled to the use of them. Also that the agreement had become merged in the assignment, and they were only liable to pay royalty on the apparatus actually manufactured by them. There was a good deal of difficulty in deciding as to the meaning of the words of the agreement, his

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lordship remarking that it had been drawn up in about the most confusing manner possible, and at some places was not even grammatical. In the event the learned Judge found for the plaintiff for the sum of £56 10s., being the amount due up to the 27th day of March, 1883.

COMPANIES' MEETINGS & REPORTS.

Eastern Extension, Australasia, and China Telegraph Company (Limited).

The twenty-third ordinary general meeting of this Company was held on Wednesday at the City Terminus Hotel, Cannon-street, under the presidency of John Pender, Esq., M.P.

The SECRETARY (Mr. F. E. Hesse) read the notice convening the meeting and the minutes of the last meeting, which were confirmed by the present meeting.

The CHAIRMAN then said: Although in the report you have a very complete, and I believe faithful, statement of the proceedings of the Company during the six months, still, as usual, I shall repeat some figures and make some remarks on the business of the last half year. The revenue for that period amounted to £248,087, against £231,056 for the corresponding period of 1883, showing an increase of £17,031. The working expenses for the past half year were £79,496, against £69,862 in the corresponding period of 1883, showing an increase of £9,634. Of this, £5,652 is due to the exceptionally heavy expenditure in connection with cable repairs, and the balance is represented by permanent expenses in opening and working the new stations at Tonquin and Macao. The net revenue for the half year was £104,228, against, in the corresponding period of 1883, £117,720, showing an apparent decrease of £13,492. As, however, £20,000 has been charged against the past half year's income on account of the renewal of cables, the net revenue in reality shows an increase of £6,508. Comparing the figures of the whole year the results are as follow:—The revenue in 1884 was £485,759, and in 1883 £444,785, being an increase during the past year of £40,974. The working expenses for 1884 were £146,155, against £132,640 in 1883, being an increase of £13,515. One interim dividend at the rate of 5 per cent. per annum has been paid for the past half year. Another will be posted to the shareholders this evening, together with a bonus of 2s. a share, making, with the distributions during the first half year, a total payment of 7 per cent. for the year 1884. The reserve fund during the past year has been increased by the following additions:—Interest on investments, £13,950; and the balance of revenue to the end of December, 1884, £33,876, together, £47,826, making the total of the fund at the close of the year £510,649, representing 20 per cent. of the share capital of two and a-half millions. During the year we have renewed weak portions of the system (12,660 knots in length) to the extent of 789 nautical miles of brass-ribboned cable. The amounts taken from revenue for this purpose were for the first half year £22,767, and for the past half year £20,000, making a total of £42,767. Up to the present time we have renewed with brass-ribbon type about 1,500 knots of cable; but there are still from 600 to 800 knots exposed to the teredo which will have to be renewed in a similar manner as opportunity offers. That gives you a very clear exposition of the working of our cables, and at the present moment I am glad to say that we have really no interruptions. But we are very seldom without them, and therefore we have to be prepared to deal with them when they occur. The principal cable interruptions, as stated in the report, have been on the Penang-Madras and the Java-Australian sections. The traffic, however, was not appreciably affected, as it was transmitted by the Company's alternative lines. The same remark cannot, however, be made in reference to the interruption of the cable between Tasmania and Victoria. Unfortunately, great inconvenience was caused to the telegraphing public of these colonies, and your Directors have therefore, with a view to giving as reliable a communication as possible, decided to duplicate the line. This will be carried out when a favourable opportunity occurs with cable from our spare stock at Singapore. With regard to our Foochow station, the negotiations to which I have referred at previous meetings, and which have been going on with the Chinese authorities for the past two years, for a more efficient communication with Foochow, have at last been brought to a successful termination by the conclusion of an arrangement for the transmission of the Company's traffic by a direct line between Sharp Peak and Foochow. This line was completed and opened to the public on the 18th ult., and effects a considerable improvement in our communication with Foochow. Having touched upon the principal points of interest in connection with the past half-year's working, it is now my painful duty to refer to the lamentable loss of the ss. "Magneta," which is alluded to in the report. It is the only really dark shadow that has come across our path since the Company was established, and has caused a great deal of pain and sorrow to many outside the Company. Simultaneously with the order for the "Magneta," a sister ship was ordered of the same builders for the Eastern Telegraph Company. We have had a great deal of experience in cable ships, and in designing these vessels an amount of attention was given to them that probably has not often been given to ships; but they were of a technical character—they were literally floating workshops, and every part had to be considered in regard to strength, and the special work which the ships have to perform. I may mention, as to the "Magneta," that the care exercised was such that when the ship was completed the excess over the contract price for extras only amounted to about £24. That I believe is an experience probably unexampled. I believe there is no such evidence of care in all the details as was shown in the building of that ship. I may also mention that the Board visited the vessel, and every one was loud in its praise. The captain who, with the chief electrician, dined with me before starting, told me that he did not believe there was a ship afloat better suited for the work than the "Magneta," that he was proud of his ship, and that he thought he would be able to give a very good account of her when she was brought into active service. So confident was he in his belief as to his safety in the ship that, although he was urged to insure his life before starting, he declined to do so, which is a very sad thing for the family, but such was the fact. I give these details simply to show you that your Board took every possible care to equip a ship which should be in every respect efficient. I took occasion to go out in the other ship, the "Electra," and experienced some very rough weather in the Bay of Biscay, but I was never on board a better sea-going boat. I may mention in conclusion that the ship was fully insured. We shall require to duplicate the vessel. I should be glad to have some expression of sympathy on your part, because it will be necessary for the Directors to do something more than to say they sympathise with the loss which some families have sustained [hear, hear]. I cannot point out any particular case where this may be necessary. I only want an expression of approval and sympathy from you, so that your Board will be able to handle the matter both with delicacy and prudence, and, I hope, with satisfaction to the shareholders. As I have just said, our cables are all in good working order, but it is difficult to say how long they will continue so. I have had a great many inquiries as to what is to be the position of our cables in the event of war. Well, gentlemen, there are altogether about 36,000 miles of submarine cables, and it is very difficult to protect such a large area as these embrace. However, we have submitted to the Government our views, and we hope that as the cables have not only become a necessity for political intercourse, but indispensable for commercial communication, that it will be deemed just as necessary to protect them as mercantile ships from privateering or other attacks. How far it is possible to carry that out is not for me to say. All I can state is that we shall have our repairing ships at the places where we consider they ought to be in the event of any breakage, and I think our position will be such that the Government will see that it is of vital importance to give us such protection as we require for the working of the cables in times of war. It is an old saying that "It is an ill wind that blows no one good." There is no doubt that war does largely increase our traffic. War is about as good a thing while it lasts for increasing the traffic as there could be, because the messages are not measured by words—they are long and continuous. It is scarcely necessary for me to go further into details at the present time, which is a very critical one. We are watching your interests in the very closest way possible, and looking at the successful report which we have put before you to-day, the increase in our reserve fund, and the growing necessity for submarine telegraphic communication, I will only add that during war we have every reason to look forward to a large traffic. I hope the war will be short, if it does occur. If it does not, looking at the great depression, which in a large measure arises through the uncertainty whether there is to be peace or war—when peace is permanently established I look forward to a very considerable change in trade. Trade gets sick many times, but it never dies, and I think the position of Great Britain, as a trading country, is such that whenever a revival takes place we shall have a large share of it, and that the telegraph service will be the very first to show the improvement. I now beg to move the following resolution:—"That the report and accounts of the Directors now submitted be "received and adopted, and that a dividend be now declared of 2s. 6d. "per share, together with a bonus of 2s. per share, both free of income "tax, payable on the 30th instant, making with the previous distribu- "tions a total payment of 7 per cent. for the year 1884."

The Marquis of TWEEDDALE: I beg to second that.

A SHAREHOLDER: Will you tell us how many persons were on board the "Magneta" in addition to the crew?

The CHAIRMAN: Nine, including some young men we were sending out to stations and to attend to other work in connection with the Company. In all, there were fifty-four on board. In reply to a further question the hon. gentleman said: The Board have just arranged to-day to replace the "Magneta"—to build a similar ship—in fact, in almost every respect on precisely the same lines. We shall of course make some slight alterations, but there is so little to do in the way of improvement that I believe the new ship will cost precisely the same as the one which has been lost.

Mr. JOHN NEWTON: Supposing there is a war, and our cables are cut, will you be permitted to charge higher rates—or war rates—for the messages sent over them?

The CHAIRMAN: I think it would not do for me to say that we would make any change or alteration in our tariff. We must wait and be guided by circumstances.

Mr. NEWTON: But you have the power.

The CHAIRMAN: We must be guided by circumstances. Our first consideration is to give a good service, and the next consideration is that such service shall benefit the shareholders.

He then put the resolution, which was carried unanimously. Continuing, he moved the re-election of Mr. C. W. Earle.

Viscount MONCK seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. F. A. BEVAN, Sir Thomas Fairbairn, Bart., was also re-elected to his seat at the Board.

Mr. GIBB next moved the re-election of Mr. Henry Dever, and Messrs. Quilter, Ball, and Company as auditors for the ensuing year, at a remuneration of £100 each.

The motion having been seconded, it was carried unanimously.

The CHAIRMAN: That closes the business of the meeting, and I hope when I meet you six months hence we shall know more about the war than to-day, if there is to be war; but I hope there will be peace.

A SHAREHOLDER moved a vote of thanks to the Chairman and Directors for their able management of the Company's affairs.

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The motion was seconded and carried unanimously.

The CHAIRMAN: I am very much obliged to you on the part of myself and my colleagues. I am always glad to see fresh faces on occasions like this approving the conduct of the Board. I can only assure you, looking at the time we have passed through and the times we are likely to pass through, your business will require a great deal of care and attention. But you may be sure that our interests are your interests, and that they will be looked after in every way.

The Indo-European Telegraph Company (Limited).

The eighteenth ordinary general meeting of the members of this Company was held at the City Terminus Hotel, Cannon-street, on Thursday last, under the presidency of Colonel James Holland.

The MANAGING DIRECTOR (Mr. W. Andrews) read the notice convening the meeting, and the chairman affixed the seal of the Company to the register of shareholders.

The report of the Directors and statement of accounts were taken as read.

The CHAIRMAN then said: Gentlemen, when we last year had the honour of meeting you, it was my agreeable duty to mention that the past year had been an uneventful one—a kind of year that is always satisfactory to shareholders. I am glad to be able to report that the year just passed—1884—has also been an uneventful one. There is one circumstance attending it that is to be regretted—very much to be regretted—namely, that commercial affairs have been very stagnant, as we all know, all over the world; and, as the result of that there has been a reduction in the net earnings to the amount of about £1,000; but we have managed to make up the revenue from other sources, so that you see the net loss, as stated in the report, is about that figure. There is also another loss to report, but one which will not very greatly grieve you, namely, a reduction in the expenditure—that is to say, it is about £1,500 less than the expenditure of the preceding year. And when we consider that not only have the wires been kept in far better order than they ever were before, no expense having been spared in keeping everything in perfect order, but also that we have laid out £2,000 as our share of laying a cable across the Straits of Kertch, I think you will admit that as regards the management of our friend, Mr. Andrews, nothing could be more satisfactory; for it is to his untiring zeal and intelligence that we owe this considerable reduction instead of what might have been expected in addition. It is impossible for me, and it would unnecessarily fatigue you, to go into all the details; but I can assure you that not a week passes through the whole year that his mind is not turned, not merely to the reduction of our expenditure, but to the improvement of our means of communication. To show to what extent they have been improved I may mention that in 1884 the average time for a message from London to Teheran has been fifteen minutes, and to Constantinople not more than half an hour. We go as far as Odessa on that line. It is impossible almost that any system of telegraphic communication could be more perfect than that. Among the items of improvement during the year I may mention that we have leased a second wire from the India Office. The German Government, on our communicating that fact to them, with the greatest promptitude placed a second wire on their system also at our disposal from Emden, the nearest point on the coast to Berlin; so that we have two wire communications the whole way to Teheran. There is also, when it is in perfect working order, a two-wire communication from Teheran to India. That portion of the line is under the management of the Indian Government, and I wish I could say that it was as perfect as our own; but it fails occasionally, and does not keep us up to the same degree of excellence that we have managed to attain with the others; but the repair, or renewal, or whatever is requisite on this line, has been taken in hand by the very energetic head of the Indian Telegraphic Department, Colonel Bateman-Champain, and as the Indian Government generally is unwilling to allow matters to slide, but as a rule acts with energy and promptitude, we have every hope that that portion during the year will be placed in as good a condition as our own. I should say that we owe the addition which the German Government has made to our line—the second wire—greatly to the good offices of that very able and energetic Minister, his Excellency Von Stephan, who, on the recognition of his merits, was lately ennobled by the Emperor of Germany. We are fortunate in having so able and efficient a Minister at the German Court. I have very little else, gentlemen, to mention to you, excepting one point, which perhaps you will observe, namely, that we carry over a larger sum than usual. We carry over, instead of a few hundred pounds, a sum of upwards of £4,000. I think that requires no special comment. We all know what the state of political affairs is at present, and we deem it essential in our interest that we should have a good sum to carry over, for no human being can foretell at what moment events may require every thing that we possess in the way of reserve. The reserve fund—which is now a regular reserve fund—amounts to upwards of £50,000, and is a very great sheet-anchor to us, or great support. I wish it were greater, but still it is a highly respectable sum, and we are glad to think that you have on every occasion supported your Directors in steadily increasing that. We think that fund and the insurance that we possess in the joint-purse agreement with the Eastern Telegraph Company of inestimable value to us. It would be indiscreet, and I have no doubt you will all understand my not doing so—to dilate upon the subject of the existing political affairs. We all know what they are, and we all know, as regards the interests of this Company, what dangers may occur. All we can say is that we have lost no opportunity amongst ourselves of endeavouring to safeguard those interests. With these remarks I will conclude by moving "That the report and statement of accounts be received and adopted."

Mr. H. WEAVER seconded the motion.

Mr. MATTHEWS: In the event of the system being interrupted, would the joint-purse arrangement still continue?

The CHAIRMAN: The joint-purse agreement gives us, as I think I stated just now, a very valuable insurance of our property for a certain time. There is no occasion to specify it, but we calculate, should any disturbance occur and last not longer, say than twelve months, that our losses will not be very material. I think, however, that we had better not go into that matter further.

The resolution was then unanimously adopted.

The CHAIRMAN: I have now to move "That a dividend be and is hereby declared for the half year ending 31st December, 1884, of 17s. 6d. per share, making with the interim dividend already paid 6 per cent. for the year, and a bonus of 10s. per share both free of income-tax, making in all 8 per cent for the year."

Mr. J. HERBERT TRITTON seconded the motion, which was carried unanimously.

On the motion of the CHAIRMAN, seconded by Major-General G. B. TREMENHEERE, the retiring Directors, Messrs. C. W. Earle and John Berenberg, were re-elected to their seats at the Board.

The auditors, Messrs. C. F. Kemp Ford and Co., were subsequently reappointed, and a cordial vote of thanks having been passed to the Chairman and Directors, the proceedings terminated.

The Oriental Telephone Company (Limited).

The fifth annual ordinary general meeting of this Company was held on Tuesday, at the Cannon-street Hotel, Mr. William Addison in the chair.

Mr. ALEX. B. CHALMERS, the secretary, read the notice convening the meeting, and the report of the Directors was taken as read.

The CHAIRMAN moved the adoption of the report.

Mr. HENRY GREWING seconded the motion.

The CHAIRMAN continued: I have a few remarks to make on the report and the position of the Company. It has been the desire of the present Board to lay the position of the Company as plainly as they could before you in the hope that the present arrangement of the accounts will show you the position plainer than they consider they have done before. Some shareholders may think, because nothing very disastrous to the Company was disclosed in the report of the Committee of Investigation, that the report was unsatisfactory. I beg to say that I think quite the contrary, and I am very glad that we had nothing more serious to say. We now know the position of the Company very much better than we did before, and I think it is not in such a hopeless condition as many of us feared it might have been. Many shareholders doubtless feel great anxiety as to the liabilities for guarantees to the Indian companies. The amount this Company will be liable for in that respect during the next three years, taking the revenues of these companies at what they are at present, and without allowing for any prospective improvement, will not probably exceed £10,000; and only under circumstances being so bad as to prevent our being able to realise any of the shares we hold in the subsidiary companies, excepting on such terms as the Directors would not feel justified in accepting, would a call of a shilling a share be necessary, and that would more than meet the whole of this liability. The contingent liability to which reference was made in the balance-sheet was a long outstanding claim of Mr. Leggatt, who was our agent in India promoting the subsidiary companies there. This has now been compromised on terms favourable to this Company. The subscribers to this Company's exchanges, and to those of the affiliated companies, numbered 1,568 in 1884, as against 1,148 in 1883, and additions this year up to latest dates show an increase of 115, representing an addition to this year's revenue of upwards of £1,000. That would be for a period of three months. Our accounts come to about the end of March. The Directors propose to limit their fees for 1885 to £500. I think, gentlemen, this is all I have to say on the report. If any of you have any remarks to make, or questions to ask, I shall be happy to answer them.

A SHAREHOLDER asked how much of the £13,625 put down as sundry debtors was considered good. He would also like to ask how much profit had been made, and what had been the working expenses, and how much dividend had been received on account of the subsidiary companies. With regard to the £10,000 which they would have to pay in the next three years, he would like to know how much of that there was a probability of this Company receiving back.

The CHAIRMAN replied that the amount of debtors, £13,600, they considered to be good; about £8,000 of it was due for the Egyptian indemnity, and a great portion of it represented sums due by different companies. £2,831 was due by the China and Japan Company, and the Telephone Company of Egypt owed them £2,135. The rest was made up of smaller amounts, but they might take them as all good.

Mr. ROBINSON KENDAL said that it was very important that it should be clearly understood that the entire amount of the guarantee for which this Company was responsible in connection with its subsidiary companies was £10,000, and if those companies were in any way successful a large amount of that would come back to this Company. He would ask, if the £10,000 were paid in its entirety, had the Directors any hopes of getting anything back for this Company?

The CHAIRMAN said the amount put down was £10,000, and that amount they might be liable for if the working of those companies remained the same as at present; but if it improved that amount would be reduced by the amount of improvement.

Mr. ROBINSON KENDAL: Then the total loss under any circumstances cannot exceed £10,000, or a shilling a share.

The CHAIRMAN: Taking our position according to the returns we have now.

A SHAREHOLDER asked how Mr. Leggatt's claim had been settled, and for what amount.

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The CHAIRMAN thought it was not advisable when a compromise had been arrived at that the amount should be stated. He would do so if it were the wish of the shareholders, but he might state that the claim had been reduced by nearly two-thirds of the original claim.

Mr. ADAMS said he must say a word on that as he was Mr. Leggatt's solicitor. He did not think that the Chairman had put it in a fair way. Mr. Leggatt's claim no doubt was for a considerably larger sum than he received, but on the other hand the Company alleged that they had a cross claim. To a certain extent that cross claim was admitted. That had been settled by the Company saying we will give you so much to settle the thing. He took the liberty of advising Mr. Leggatt he had better accept the sum offered him rather than go into litigation with a powerful company. He might say this further, as there was no reason why he should keep it back. When the litigation was begun there was another Board of Directors, and no doubt many of the circumstances connected with Mr. Leggatt's claim affected the individual members of that Board very considerably. They did not affect any of the gentlemen who now sat on the Board; they could fight this case through, and they could have fought it without any fear that any facts could come out that would affect them individually. He would not go so far as to say that the old Board would have suffered in reputation, but there was a certain amount of speculation in reference to the old Board that did not apply to the new Board. He could not say that Mr. Leggatt was content, or that he (Mr. Adams) was content for him, but it would not have been wise for an individual like Mr. Leggatt, who had not much money, to fight a great Company like this.

The CHAIRMAN did not see that the remarks that had been made affected the correctness of the statement he had made.

Mr. HALL said that he was pretty familiar with the circumstances of the case. He was sorry to hear any reflection on the old Board. The old Board was determined to see the thing through, but they had no desire to press hard on a servant of the Company, and they did suggest a compromise, which at the time was refused. It had since been accepted, he thought to the advantage of the Company and also to the advantage of Mr. Leggatt, but he did not think it was fair to gentlemen who were not present that Mr. Adams should say anything reflecting on them individually.

Mr. ROBINSON KENDAL said that although the accounts submitted were not so favourable as they might have been, yet under all the circumstances he thought there was every hope in the future for this Company. With regard to what Mr. Hall had said respecting the late Board, he thought the shareholders were fortunate in having had a report from the Committee of Investigation, who had really discovered nothing of any great importance. The committee expected to find gross inaccuracies, if not malversations, in the affairs of the Company, and the shareholders now had an exact statement of the position of their affairs, and if they left out of the report of the Committee of Investigation injudicious management, for which all men were liable, and if they left out also that after-wisdom for which all men were celebrated, they must come to the conclusion that there was nothing in the report which seriously reflected on the late Board of Management. Personally he had nothing to do with the late management. The Chairman, one of the Directors, and the Secretary assured him that there was nothing wrong in the affairs of the Company, but there might be some few errors of judgment, and he thought that the report of the Committee of Investigation fully verified that statement.

The motion for the adoption of the report was then put and carried.

The retiring Auditors were re-elected, and the proceedings then terminated.

Brazilian Submarine Telegraph Company.

Report and accounts of the Directors for the half-year ended 31st December, 1884, to be submitted to the twenty-third ordinary general meeting, 7th May:—

The revenue for this period amounted to £89,385 3s. 11d., and the working expenses to £21,851 2s. 1d. (including £8,737 6s. for repairs of cable). After providing £8,066 13s. 4d. for debenture interest and sinking fund, and £1,005 14s. 4d. for income tax, there remains a balance of £58,461 14s. 2d.; to this is added £331 2s. 4d., brought forward from 30th June last, making a total of £58,792 16s. 6d. First and second interim dividends amounting to £39,000 have been paid, and £17,000 transferred to the reserve fund, leaving the sum of £2,792 16s. 6d. to be carried to the next account. Since the last general meeting two interruptions of the Company's cables have occurred; one was caused by a ship's anchor disturbing the new Madeira—St. Vincent cable on the 28th November, and the other, which took place on 3rd January, in the old St. Vincent—Pernambuco section, was due to friction upon a reef. The repairs were effected on the 18th December and 19th February respectively, the regular transmission of traffic having been in no way interfered with. All the Company's cables are now in good working order.

Submarine Cables Trust.

Report of the trustees to the fourteenth ordinary annual meeting of the certificate holders, to be held at the offices of the Trust, 66, Old Broad-street, on the 12th inst.:—The revenue for this period, including the balance brought from the previous accounts, viz., £3,943. 9s. 5d., amounted to £24,449. 3s. 6d. Since the last report was issued the trustees have purchased nine certificates at a cost of £886, thus reducing the number of outstanding certificates to 3,381, and the capital of the trust to £338,100. The expenses of the Trust for the twelve months amounted to £1,324. 6s. 10d. The payment of two half-yearly coupons at the rate of 6 per cent. per annum absorbed the sum of £20,289, leaving a balance of £1,949. 16s. 8d. to be carried forward. The dividend and bonus on the Eastern Extension Company's shares (£2,967. 11s.) recently announced, but not payable until 29th April, will be included in the revenue for the current financial year. The securities held by the trustees remain unchanged. The meeting will have to elect two auditors for the current year. Mr. John G. Griffiths and Mr. John Gane offer themselves for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

Companies.	Closing Prices. April 29.		Business Done Week Ending April 29. Highest.	Lowest.
Anglo-American	27,	28	28¼	27¼ x.d.
Do. Preferred	47,	48	49	47¼ x.d.
Do. Deferred	6¼,	6½	6¾	—
Brazilian Submarine	10⅛,	10⅜	10 13-16	10⅛
Cuba	10½,	10⅝	—	—
Do. Preference	17,	18	17½	—
Direct Spanish	1½,	2	—	—
Do. Preference	9½,	10½	—	—
Direct United States Cable	8¾,	9	9½	9
Eastern Telegraph	10⅝,	10⅝	11¼	10 5-16
Do. 6 per Cent. Preference	13½,	13⅝	13⅝	13½
Do. 5 per Cent. Debentures, 1899	105,	103	105½	—
Eastern Extension	11⅝,	11⅝	12½	11⅝
German Union	9½,	9¾	—	—
Globe Telegraph and Trust	6⅝,	6¾	6⅝	6 5-16 x.d.
Do. Preference	12⅝,	12⅝	12 9-16	12½ x.d.
Great Northern	13,	13½	13⅝	13½
Indo-European	29,	30	30	29½
Reuter's	7½,	7¾	7½	—
Submarine	175,	185	177	—
West India and Panama	⅝,	¾	13-16	—
Do. 1st Preference	7½,	7¾	7 9-16	—
Western Brazilian	5⅝,	5¾	5 11-16	—
Western Union 7 per Cent. 1st Mortgage	120,	125	—	—
Do. 6 per Cent. Sterling Bonds	100,	103	—	—

TELEPHONES.

Consolid. Telephone and Maintenance	⅜,	½	7-16	—
Oriental	⅛,	⅜	3-16	⅛
United Telephone	10⅛,	10⅜	10⅜	10

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1½,	1¾	1¾	—
Do. (fully paid)	8½,	8¾	—	—
Hammond Light (£3 15s. paid)	⅛,	¼	¼	—
Swan	—	—	—	—
Maxim-Weston	⅛,	¼	—	—

MISCELLANEOUS.

Telegraph Construction	33,	34	34	33
India Rubber, Gutta Percha, and Telegraph Works	20½,	21¼	21½	20½

THE EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH COMPANY (LIMITED).

5 % AUSTRALIAN GOVERNMENT SUBSIDY DEBENTURES.

NOTICE IS HEREBY GIVEN, that in conformity with the terms of the Trust Deed dated 10th May, 1879, the undermentioned numbers of Debentures were drawn by lot on the 29th April, at the City Terminus Hotel, Cannon-street, in the presence of John Pender, Esq., M.P., Sir James Anderson, and others, and of John Venn, Esq., Notary Public.

The said Debentures will be paid off at par on the 1st July next, at the Banking House of Messrs. Barclay, Bevan and Co., 54, Lombard-street, after which date interest on them will cease.

239 Debentures of £100 each.

12	775	1687	2496	3308	4050	5040	5717
13	788	1690	2540	3327	4162	5077	5720
16	805	1696	2573	3411	4180	5104	5739
39	816	1742	2585	3412	4250	5105	5756
82	833	1767	2611	3417	4256	5110	5777
84	839	1787	2617	3428	4286	5152	5793
112	867	1857	2619	3467	4330	5155	5799
123	908	1879	2645	3472	4350	5168	5802
162	972	1932	2663	3502	4377	5171	5809
171	984	1939	2701	3545	4387	5203	5843
223	1032	1989	2720	3568	4398	5246	5845
289	1049	1991	2728	3599	4405	5285	5850
290	1059	2082	2745	3618	4411	5294	5859
291	1143	2135	2751	3699	4488	5298	5931
328	1152	2149	2786	3700	4476	5300	5952
355	1174	2158	2789	3730	4492	5317	6001
374	1202	2206	2894	3789	4507	5320	6019
423	1208	2223	2897	3744	4544	5339	6052
438	1241	2260	2924	3745	4647	5356	6056
459	1258	2262	2941	3763	4681	5391	6064
468	1329	2297	3065	3814	4689	5398	6094
492	1349	2301	3101	3851	4700	5423	6144
496	1366	2308	3150	3871	4814	5473	6147
548	1379	2326	3163	3900	4827	5511	6194
566	1407	2333	3179	3948	4832	5533	6218
577	1431	2375	3181	3975	4860	5579	6234
589	1505	2378	3223	3976	4899	5593	6325
610	1554	2400	3243	3987	4955	5624	6369
665	1577	2436	3247	4003	4973	5635	6370
774	1593	2462	3273	4018	5029	5709	

Witness: JOHN VENN, 9, Gracechurch Street, E.C., Notary Public.

By order of the Board, F. R. HESSE, Secretary.

66, Old Broad Street, London, E.C., April 30th, 1885.

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NOTES.

THE SOUDAN TELEGRAPH LINE.—The telegraph poles and wires have again been destroyed.

NOTICE OF INTERRUPTION.—The Paris and New York Telegraph Company's cable is interrupted.

THE SUBMARINE TELEGRAPH CABLES BILL.—On Tuesday night this Bill passed through its third reading.

FIRE AND WATER.—Some ice houses at Indianapolis, Ind., have been struck by lightning and *burned down*.

SUPERSTITION.—The Charleston negroes believe that if a man is struck by lightning he will never be able to swim again.

THE TELEGRAPH TO MERV.—The Russian telegraphic line towards Merv is completed as far as Kahkaha, 120 miles east of Askabad.

THE WASHINGTON MONUMENT.—The Washington monument has been struck three times by lightning without being in the least damaged.

THE BRAZILIAN SUBMARINE TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 1st May amounted to £3,172.

A GOOD SUGGESTION.—The Seismological Society of Japan has suggested the use of telegraph stations to give warning of the approach of earthquakes.

ANGLO-AMERICAN BRUSH ELECTRIC LIGHT CORPORATION.—The Right Hon. Lord Sudeley has joined the Board of Directors of this Corporation.

APPRECIATIVE—The Citizen's Gas Light Company of America are now perfecting arrangements for putting in a plant for electric lights at their works.

TELEMETRY.—Telemetry has been practically applied in America, and has given excellent results, the temperature registrations being exceedingly accurate.

TELEGRAPH FOR THE BLIND.—A telegraph instrument has been designed for the use of blind or deaf people, the vibrations being read or interpreted by the fingers.

THE CENTRAL STATION AT TOURS.—The works at the Central Electric Lighting Station at Tours, already mentioned in our columns, are being rapidly pushed forward.

THE MOON AND ELECTRICITY.—It is stated that there are periodical variations of intensity in terrestrial currents in direct relation with the movement of the moon or the tides.

UNDERGROUND WIRES IN AUSTRALIA.—The telegraph and telephone wires at Melbourne, Australia, are being put underground, great objection having been offered to their presence overhead.

CORRECTING WEIGHT BY ELECTRICITY.—A German mining engineer has introduced the practice of bringing light coins of silver and gold to the standard weight by electro-deposition of the metal on their surfaces.

THE ELECTRIC LIGHT FOR WAR SHIPS.—Messrs. R. E. Crompton and Co. have been instructed by the Admiralty to make seven more sets of electric light machinery for ship use and twenty more projectors.

TELEGRAPH PLANT FOR INDIA.—A contract has been received by Messrs. E. Lucas and Sons, Dronfield Foundry, near Sheffield, for 20,000 telegraph pins for Bombay. They are galvanised, and of very great strength.

DEFENCES OF VICTORIA.—The Victorian Government announce that electric lights may be exhibited at any time from Queenscliffe and Point Nepean for defence purposes, but such lights must not be taken as guiding signals.

THE ELECTRIC LIGHT IN THE DARDANELLES.—The Special Commission sent to inspect the defences of the Dardanelles recommends the establishment of torpedo stations along both shores, and the employment of the electric light to prevent a surprise at night.

PERSONAL.—Major H. S. S. Watkin, Royal Artillery, from Assistant-Superintendent Royal Gunpowder Factory, Waltham Abbey, has been appointed an instructor in topographical science and applied electricity in the Department of Artillery Studies at Woolwich.

CABLE FOR PORT HAMILTON.—The *Globe* understands that an electric cable, connecting Port Hamilton with the nearest station of the Eastern Telegraph Company, a distance of 350 miles, is being laid. The cable is not yet electrically complete, but it is expected that it will be in working order shortly.

THE SOCIETY OF TELEGRAPH-ENGINEERS AND ELECTRICIANS.—The next meeting of this society will be held at the Institution of Civil Engineers, 25, Great George-street, on Thursday, 14th inst., at 8 p.m., when a paper will be read on "Electrical Definitions, Nomenclature, and Notation," by Prof. Andrew Jamieson, F.R.S.E.

THE ELECTRIC LIGHT FOR MINES.—M. Gaston Trouvé has just perfected an electric glow lamp destined for use in explosive atmospheres. In order to obtain simplicity, the lamp is constructed either to kindle itself on being taken up in the hand, or on being hung up or set down on a stable support.

TELEPHONE RECEIVERS.—The Signal Engineering Company are manufacturing an improved telephone receiver. They claim that by use of a specially designed machine for making the membrane diaphragms and other improvements in manufacture, the instruments will work quite equal to Bell telephones.

CONSOLATION.—The *Norristown Herald* says:—The Supreme Court of Ohio has decided that a subscriber cannot swear over a telephone line without the consent of the company. But the subscriber can derive consolation from the fact that he is still permitted to swear at the company without the consent of the telephone line.

ENTERPRISE IN SPAIN.—Tenders are asked in Madrid for the supply of the material for, and the installation of an electric motor and lighting system, together with a number of receivers, telephones, bells and indicators, lightning conductors, and a clock. Estimate, 34,975 pesetas. Particulars at the Ministry of Finances, Madrid. Tenders 13th May.

AN ANCIENT STRING.—An American society has just come into possession of a piece of the cord which was attached to the famous kite which Benjamin Franklin flew in 1750. It is a fine copper wire, insulated with linen twist. It is said to have been in possession of the donor, who also possesses the original (absolutely the original) club with which Captain Cook was killed, for 50 years.

BOMBAY.—The superintendent of the Eastern Telegraph Company at Bombay, writing on the 10th ultimo, says:—"The news to-day is very warlike. Admiral Sir Wm. Hewett writes: 'We must guard your cables in case of war.' At the present moment it may interest you to know that of 29 members of this staff 24 are volunteers, 10 of whom are 'extra efficients' and 12 efficients."

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ANOTHER ELECTRIC RAILWAY.—An electric railway is about to be constructed between the village of Saint-Maurice and Pontresina. The motive power will be derived from the waterfall of l'Inn, which will also be utilised to supply the force necessary in the electric lighting of the village. It has been specially stipulated that the new railway shall not in the slightest degree detract from the beauty of the neighbourhood.

COMMUNICATION WITH TRAINS IN MOTION.—Some further successful tests have just been made of the Phelps system in America. Messages were sent and received while the train was running at a rate of 30 miles per hour. The Edison system of railway induction telegraphs utilises the metallic covering of the cars and requires the wire that carries the inducing current to be brought near the roof at various points along the track.

THE INVENTORIES.—The Commissioners of the International Inventions Exhibition have adopted the B.T.K. accumulators in connection with the lighting of the Subway. Eighty of the No. 2 cells are being fitted, a portion of them having been working from the day of opening. The "Consolidated" incandescent lamp of 20 candle-power (90 volts) will be employed in lighting Spiers and Pond's Temperance Refreshment Rooms at the Exhibition.

A NEW EXHIBITION.—A new exhibition has recently been opened in the Champs Elysées, in Paris, in which electricity is largely represented. The Edison Company illustrate the transmission of electrical energy, and have a somewhat novel arrangement in that the generating dynamo actuates at the same time the receiving dynamo and a number of incandescent lamps. Siemens has also put in a small installation of Swan 8 candle-power lamps distributed through the buildings.

UNDERGROUND WIRES IN AMERICA.—The Senate Committee on Miscellaneous Corporations has authorised the appointment of three commissioners to receive the plans which the telegraph companies have prepared to put their wires below ground in New York by November 1. If such plans are not submitted to the commissioners in sixty days after the bill becomes a law, they are authorised to draw up their own plans, and put the wires underground at the expense of the companies.

LIGHTING THE DOVER TURRET.—It has been decided to illuminate the turret on the Admiralty Pier at Dover by means of the electric light, the apparatus for which is being fixed. The turret has hitherto been lighted with gas, but, for different reasons, it has been found advisable to adopt the electric light in the incandescent form. The latter, however, will not be introduced into either the ammunition chamber, which is under the centre of the turret, or the fighting deck, where the 80-ton guns are placed.

ACCUMULATORS.—The electrical engineering works of Messrs. Elwell and Parker, of Wolverhampton, continue to be very busy. The accumulators are continually being increased in size, and now a single accumulator is made which weighs 50 tons, and stores 500 horse-power for lighting. They are also making a battery to supply 3,000 incandescent lamps for the new Central Station, Manchester. Another battery is being made for Sir Thomas Bazley's seat, Hatherop Castle, which will light 750 lamps. The dynamo will be worked by a turbine.

THE NATIONAL TELEPHONE COMPANY. — The National Telephone Company last week completed the new line to Coatbridge and Mossend, connecting their Glasgow exchanges with these places. They have opened an exchange in Coatbridge, with which Coatbridge and Mossend firms are connected, and have made a start with 11 subscribers in Coatbridge and three in Mossend. The wires are working admirably, and the speaking is as clear as in a short distance. Since their erection the wires have been kept constantly at work. It is purposed to keep the Coatbridge Exchange open day and night.

THE ANTWERP EXHIBITION.—This Exhibition was officially opened on Saturday last by the King and Queen of the Belgians. Certain parts of the premises are, we are informed, thrown open each evening to the public. These are the machine works and industrial galleries, and the gardens. Three different systems of lighting are simultaneously employed, *i.e.*, electricity, gas, and petroleum. The former is used in the lighting of the machine rooms, the central industrial gallery, and the gardens; the gas in the works gallery; and petroleum in the public restaurant, which has been established in the open air.

HER MAJESTY'S THEATRE.—This theatre will be opened during the latter end of the present month by Messrs. Boracchi and Corti, the lessees of the Scala Theatre, Milan, with a grand spectacular ballet by Chevalier Manzotti, of Milan, in which electricity plays a great part in the scenic effects. Mr. Shepherd, who is known in Italy for his practical applications of gas and electric lighting for private and public illuminations, and for his successful introduction of the Edison light at La Scala Theatre, Caffe Biffi, the City of Udine, and several industrial establishments in Italy, has been requested to provide the necessary apparatus.

KILL HIM!—An American contemporary gravely announces that a new telephone has been invented by which the crying of a baby may be heard at a distance of a hundred miles. This is an application of the telephone which will make the most nervous individual desirous of interviewing its inventor with a shot gun. Of the eighty-six millions or so of people who drag out an already troubled existence in this country and in America, there may be a dozen or two who yearn to hear the yells of a baby a hundred miles distant, but we doubt it. A contrivance that would prevent the crying of a baby being heard at a distance of ten feet, says our contemporary, is what the sleepless parents of this country demand.

CROSSING THE CHANNEL BY ELECTRICITY.—We are indebted to a contemporary for the information that Mr. Reckenzaun, who has done much for the application of storage batteries to tramcar locomotion, has produced designs for a a torpedo-service launch, to be propelled at high speed by electricity. The conditions enjoined are that this craft should make a voyage across the English Channel and back in moderately fair weather. It is confidently believed that the test can be complied with, and the construction of the vessel and machinery is to be commenced without delay. In view of important improvements in the electrical appliances her speed may be expected to exceed anything hitherto attempted.

THE SS. "CHILTERN."—We learn from Madeira that the ss. "Chiltern," belonging to the Eastern Telegraph Company, has lately completed the laying of two more 4-core cables, for the Portuguese Government, across the Tagus, at Belem. Both cables are powerfully armoured, being furnished with the same type of sheathing as the shore-ends of all the recently laid duplicate sections, excepting that the weight is 22 tons to the knot compared with the 16 tons per knot of the cable shore-ends. Having completed the work, the "Chiltern" left immediately for Gibraltar, *en route* for Zanzibar, to relieve the

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repairing ship of the Eastern and South African Telegraph Company, the "Great Northern," which has been stationed there since the commencement of 1880.

THE TELEPHONE IN FRANCE.—On the 23rd ult. the number of subscribers of the Société Générale des Telephones was 5,729, as against 5,584 on the 1st of last January. The following figures will give a definite idea of the progress which has been made during the last year. The increase in the number of subscriptions in Paris from the 23rd of April, 1884, to the 23rd of April, 1885, was 332; Bordeaux, 25; Havre, 13; Lyon, 78; Marseilles, 21; Rouen, 16; Nantes, 5; Oran, 6; and Saint-Pièrre-les-Calais 4. The number of lines in actual service is 5,641, of which 3,722 are in Paris. We are informed that some further experiments with the Van Rysselberghe system of telephony are about to be made between Paris and Rheims, a distance of 172 kilometres (106·64 miles).

LIGHTING OF TAY FERRY STEAMERS BY ELECTRIC LIGHT.—The Tay Ferries Committee had under consideration on 30th April a report from the harbour engineer in regard to the better illumination of the Tay Ferries' steamers by the adoption of electric lights, and stating that he had received offers from two companies to supply the necessary machinery and lamps for the sum of £175, and that after examination he recommended the acceptance of the offer of the Edison and Swan United Electric Light Company. The committee agreed to defer consideration of the report till another meeting, and the harbour engineer was instructed to prepare and lay before the committee an estimate of the annual expense which such a system would entail as compared with the present system.

SMART WORK.—Rather a smart feat in electric lighting was accomplished on Monday last at Messrs. Palmer and Co.'s dry dock, Jarrow-on-Tyne, where H.M. transport "Albatross" has been placed for repairs, the completion of which being urgently required necessitated working continuously night and day. In order, therefore, to facilitate the work, Messrs. Palmer considered it advisable to light the dock by electricity, and it is satisfactory to learn that within 8½ hours after receipt of instructions Messrs. Clarke, Chapman, and Co., Gateshead, had one of their new portable electric light machines and boiler delivered at Jarrow, and everything in full working order, the light giving the greatest satisfaction. Evidently such a machine would be very useful during the execution of hurried repairs on board ship, or when docking vessels.—*Liverpool Journal of Commerce.*

TELEPHONES.—The number of sets of telephones exported by the Continental and Tropical American Telephone Company since its contract with the American Bell Telephone Company is said to be as follows:—

	Sets.
Brazil	2,613
Buenos Ayres	2,483
Mexico	3,197
West Coast, South America	911
Venezuela	635
Cuba	592
West Indies	488
Spain	292
U. S. of Colombia	222
Central America	153
	11,586

THE ELECTRIC LIGHT IN GERMANY.—A number of trains on the Frankfort-Fulda-Ulm line are fitted up with a dynamo placed in the luggage van on one side and accumulators on the other side. The dynamo, at a rate of 750 revolutions per minute, gives a current of 12 amperes. The dynamo is driven from one of the axles of the van, in a similar manner to the plan adopted on the London, Brighton, and South Coast trains. The cost of installing the plant is given at £120 for dynamo, driving gear, and accumulators, and at £3. 4s. to £5 per passenger coach. The light itself is estimated to cost about three farthings per lamp hour.—The Edison Company of Germany are about to introduce two new types of arc lamps, which may be placed in derivation in an incandescent lamp circuit. The first of these are of from 300 to 400 candle-power normal, and require a current of 3·5 to 4·5 amperes; while the second gives from 800 to 1,090 candles, with 8 to 9 amperes of current.

A DISINTERESTED LEGISLATOR.—A Belgian contemporary, *La Chronique*, says that some degree of excitement has been caused by the speech of M. Léon Somzée in the Legislative Chamber. M. Somzée is in opposition to the Minister of Railways, who very properly wishes to light all the principal railway stations of the Belgian State by electricity, and incontinently declares that the electric light *ne vaut pas le Diable.* This theory, ventilated in full Parliament, has somewhat exasperated the shareholders of the Société d'Electricité, of which M. Somzée is administrator! It was only after reading the singular discourse of their *mandataire* that they ascertained the fact that the perfidious M. Somzée combines a love of politics with the profession of a gas engineer, and that all his tendresses are therefore naturally reserved for gas, of which he is in a manner of speaking the representative in Brussels.

THE ELECTRIC LIGHT IN PARIS.—We announced in a previous issue that the Edison Society had been instructed to put down an installation of electric light in the offices of the Lycée Louis-le-Grand, situated in the Rue d'Assas. A few experiments were made last week in the presence of the Minister of Public Instruction to determine the best disposition to be adopted for the lamps in the school rooms, and it was then decided to place one lamp of 10 candle-power to each form of four students. A new diorama, which has recently been placed on view in the Champs Elysées, has also received an installation from the same society. This comprises two Edison A dynamos of 100 lamps, a Weyher and Richemond engine of 25 horse-power, and a Belleville boiler. Each tableau is lighted by twenty lamps of 16 candle-power. The passages, staircases, and entrance of the building are also lighted electrically. The new shops of the Maison Boudet, situated at the angle of the Boulevard des Capucines, and the Rue des Capucines are about to receive an installation from the Société le Chrôme, the current being supplied by chromic acid batteries.

THE ELECTRIC LIGHT IN AMERICA.—The Albany Board of Contract and Apportionment has awarded a contract for supplying electric light to the Albany Electric Illuminating Company for five years at fifty cents. per lamp per night for light and attendance, and seven dollars per year per lamp for cleansing lamps. The electric head light recently placed on one of the suburban locomotives of the Illinois Central Railway Company not only gives a brilliant light and illuminates the track for a long distance, but has far greater penetrating power in a fog than the ordinary light. The light is furnished from a small engine with dynamo attachment on the locomotive, and is run with steam from the locomotive boiler. The Aldermen have granted the Citizens' Electric Illuminating Company the right to light certain thoroughfares of the western district of Brooklyn, N.Y., the lamps to be each of 1,200 candle-power;

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152 electric lights of 1,200 candle-power, 200ft. apart, would be required for this purpose. The cost of the lights would be £5,548, or £36. 10s. each per annum. Should the lights be of 2,000 candle-power, 270ft. apart, 108 lamps would be required, costing £5,518. 16s., or £51. 2s. each. The number of gas lamps displaced would be 852, which cost yearly for lighting £3,496. 14s.

BLEACHING BY ELECTRICITY.—In continuation of our remarks on this subject, we cut the following recipe from the *Dyer*:—Into a cold solution (containing 1 per cent. of bromine) there is poured 1 per cent. of caustic soda at 36° B, or the equivalent of another alkaline base; then the vegetable textile (previously wetted and perfectly saturated with water) is introduced, and is left in the bath until discoloration takes place. After a passage through acidulated water, drying and rinsing take place. One per cent. of sulphuric acid or of nitric acid, poured into the bath when the latter is exhausted by successive discolorations, suffices to place the bromine once more at liberty. By then adding the same proportion of caustic soda, the hypobromite of soda is regenerated. The hydrofluosilicic acid, in composing the bromide and the bromates, forms an insoluble salt of fluosilicate of sodium, which it is easy to eliminate by decantation. In this case there are neither sulphates nor nitrates mixed with the water containing bromine. In the last place, if during the bleaching there are placed in the bath the two electrodes in carbon of one pile, the decoloring oxygen is constantly renewed by the reformation of hypobromous acid. It has also been found that a bath entirely exhausted—that is, only still containing bromides and alkaline bromates—is regenerated by the passage of the current. The same phenomenon is produced with chlorine and its oxygenated compounds. In fact, therefore, M. Bonneville recommends the industrial employment of bromine and hypobromites in the bleaching of vegetable textiles, the regeneration of the baths by acids, and more specially by hydrofluosilicic acid; and the reconstitution of the decoloring power of bleaching agents by means of electricity.

STUDYING TELEPHONE CURRENTS.—Prof. Charles R. Cross has recently described, before the Institute of Technology at Boston, some new apparatus for the study of telephone currents. His first step was to describe at length the method in which currents are formed in the wires of the telephone circuit, and how the changes in their intensity are made to reproduce vibrations caused by the voice. Any ordinary one-direction current, he showed, was easily measurable by the galvanometer. But the telephone current sometimes ran in one direction, sometimes in another, the alternations being very rapid. To obtain indications of such currents as these a special galvanometer had to be used. It was formed of one coil of wire inserted within another, the centre coil being kept in position by a torsion suspender. A current sent through both these coils at the same time tended to bring them both into a position of parallelism towards each other. When reversed, the current was reversed in both coils at the same time, the effect upon the centre coil being thus not intermittent, but continuous, and in the same direction, according to the strength of the current, no matter how often it might be reversed. The centre coil carried a mirror reflecting a beam of light upon the wall, and as the tendency was towards parallelism or away from it, the spot of light was moved as on a scale. This experiment was tried with great success. When the loud-speaking transmitter was used the deflection was very marked; the Bell telephone gave results much inferior. It ought to be mentioned that the effects were only produced with single vowels, such as a, o, u, and y. Judging from the results thus far obtained, Professor Cross was enabled to declare the telephone current to have an enormously greater strength than it has hitherto been supposed to possess.—*Electrical World.*

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—Mr. Alexander Wood, the managing director of this company, has written a letter to the *Financial News* respecting the dispute which has arisen between his company and the Brazilian Government. From it we extract the following:—"The Western and Brazilian Company is the holder of a concession from the Government of Brazil, giving it for 60 years an exclusive right to lay and maintain submarine telegraph cables along the coast of the empire, touching at various ports; in this concession it is stipulated that 'the Government shall remain at liberty to establish electric telegraph communication by land to and from such points as it may deem most convenient, and in the mode which may seem to it best administratively, or by means of a private company; but the tariff of the private lines which compete with those of the concessionaire are not to be lower than those of the submarine lines.' It also contains a clause which stipulates that the parties who may send messages shall be at liberty to forward their telegrams 'either through the submarine cables or by land lines which may be hereafter constructed.' In the year 1878, or five years after this company had been constituted, the Brazilian Administration completed a system of land lines, running parallel with the cables of this company, and connecting all the ports at which said cables touch. Their real object was, however, only too soon apparent, as the tariff upon them was ultimately reduced to a rate which could under no circumstances yield a profit, and which, contrary to the letter and spirit of the concession, showed open hostility to the company. Prompt representations were of course made to the Government, but finding that it received no redress, and that the company could no longer hope for impartial treatment, it under strong protest lowered its tariff to that of the Government lines. Prior to this change of rate the proportion in which the international traffic had been shared was as follows:—The Government took some 44 per cent., the Western and Brazilian Company some 56 per cent., the rates then, be it remembered, being in the case of the Government 1 and 2 francs, and in the case of the Western and Brazilian Company 5½ and 8 francs respectively. As a natural result of this reduction active competition ensued between the land lines and the cables of this company, and the Government got very much the worst of it. The Brazilian Telegraph administration is now said to be about to urge the Government to resort to another and less worthy expedient for improving its position, and it is suggested that the Government should seize upon one paragraph of the concession of the Brazilian Submarine Company and declare that the companies had no right to enter into an agreement which it is alleged is detrimental to the interests of the State, this, too, after said agreement has been in full force for twelve years. In no case has the English investor graver cause for complaint than in this instance, when English capital has been liberally expended on the faith of Brazilian Imperial promises; and if this company is at last to find itself face to face with a high-handed attempt, not only to render the concession which was granted with a great flourish of trumpets abortive and a farce, but also to force the hands of the public to divert their messages from the cables to the land lines, an outcry must ensue, not only in Brazil, but wherever our customers are to be found, when I have no fear as to the verdict which the tribunal of public opinion will pass upon the whole question."

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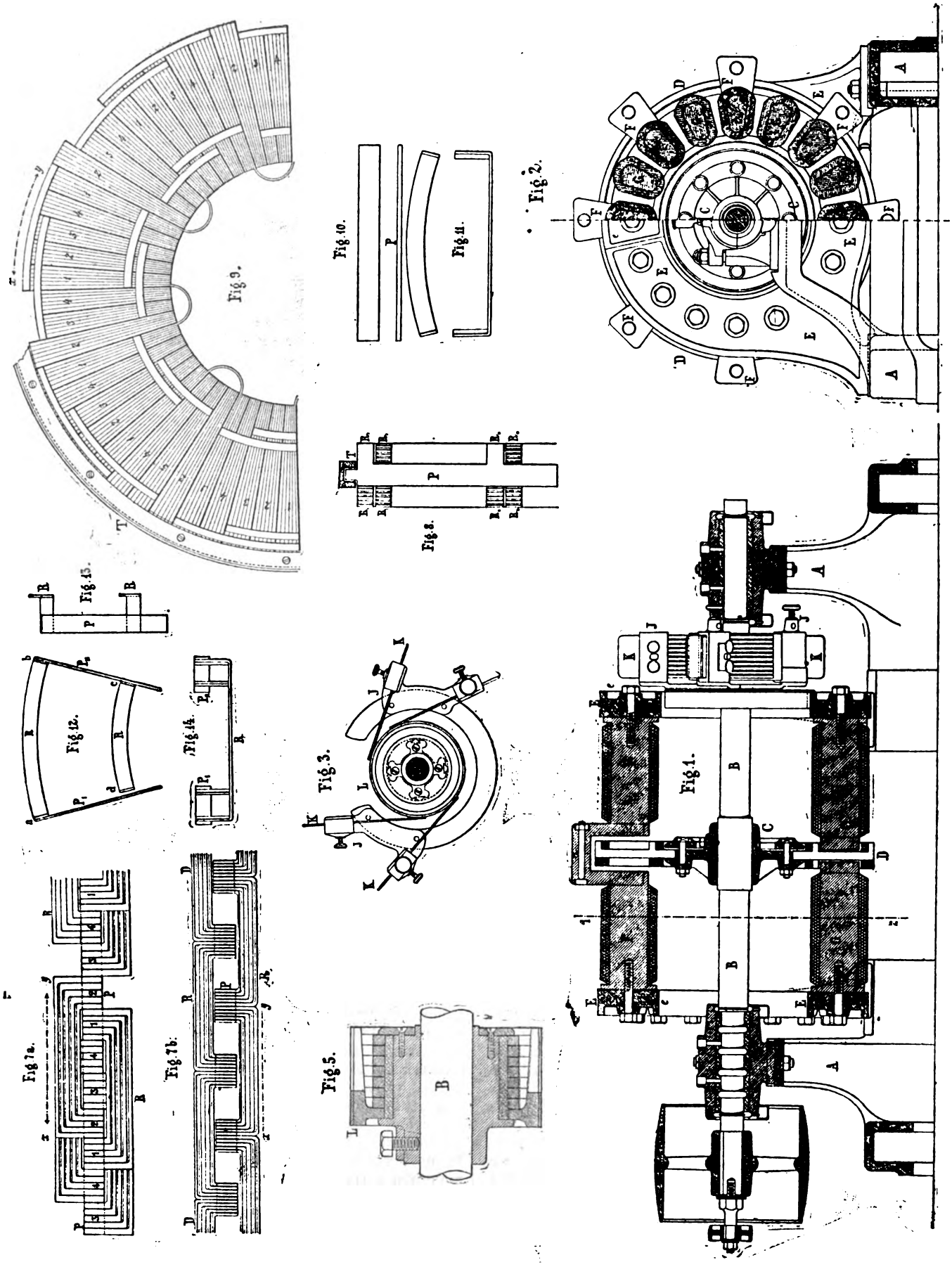
SOME RECENT IMPROVEMENTS IN DYNAMO MACHINES.



For some time past Mr. L. Bollmann, of Vienna, has been engaged in devising improvements to various kinds of electric lighting apparatus, and more recently in the design of a new dynamo, of which great things are expected. The improve-

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ments which form the subject of our article are among the most important, perhaps, of his designs, in that they relate to three important features in a dynamo having *no iron in its rotating armature*. Broadly speaking, these improvements consist of a peculiar construction of the armature, a new arrangement of the stationary magnets, and of an improvement in the frame, permitting the armature shaft to be easily removed.

Of the drawings given below, Fig. 1 is a section of the entire machine; while Fig. 2 shows a part elevation and a section through the line 1—2 drawn on Fig. 1. In the preliminary experiments which were conducted by the inventor the machine had only 12 pairs of magnets, with open poles, as G G in Fig. 2, and arranged upon the same plan as shown. The pole pieces were 95 millimetres, and the intervening spaces 55 millimetres in breadth, the measurements being taken on the outer circumference. The magnets were in shunt connection, partly in parallel and partly in series; the weight of the whole 24 magnets with windings being 312 kilogrammes, while the weight of the armature disc was 30 kilogrammes of copper. The part between the flanges C, was an inactive weight of about six kilogrammes, thus leaving 24 kilogrammes active. The outside diameter was 60 centimetres, and the thickness between the pole pieces 12 millimetres. The parts were arranged so as to form four circuits, and the length of all radial and circular parts, such as $R_{,} R_{,,}$ in each circuit, was 17 metres in 40 circles, about half of this being in the radial and the remaining portion in the circular parts. The four circuits were connected direct to the commutator in parallel. Of these there were always two and sometimes three in contact with the brushes. In the case of two circuits being in parallel, the internal resistance of the disc was ·002 of an ohm. The total weight of the machine was 700 kilogrammes, and the tension of the current at a speed of 725 revolutions per minute was 38 volts, while at a speed of 775 revolutions per minute the tension was increased to 55 volts. The lamps used, numbering 700, were of 12 candle-power, and it was found that if the number was reduced from this quantity to 100, the variation of the current was only 5 volts, while the changes that took place between 300 and 100, and between 700 and a single lamp were 3 and 8 volts respectively. Upon 1,000 lamps being connected up, and the speed reduced, the alteration of the current was in the same proportion. We are, furthermore, informed that no sort of mechanical regulation was resorted to, and that the disc and magnets remained at their normal temperature. The effects of the machine are said to have been due to the exceedingly small resistance in the disc; to the disposition of copper in the disc, so that the inductive action is uniform; to the connection of the several circuits of the disc in parallel at the commutator; to the absence of iron in the armature; and to the extremely powerful magnetic field distributed over the entire disc. We may now consider the construction in detail.

The frame proper of the machine is constituted by the parts A and E E, while B is the main shaft carrying the double flange C, by means of which the armature disc D is connected to the shaft by a screw, as shown in Fig. 1; an insulating substance being placed between the flange and the disc. To the stands E E are fastened the stationary electromagnets G and F; those situated opposite one another having opposite poles, and those standing side by side having also opposite poles, so that alternately a north pole follows a south pole on the same side of the disc D. There are 16 pairs of magnets used, and they may be arranged in either of the following methods, viz.:—(*a*) All magnets have open pole pieces as G G (Figs. 1 and 2), which stand close to the disc D, but without hindering the rotation of the latter; or (*b*) Every second pair is connected together by iron connecting pieces like F F, which are bent out to form bridges for the disc D to pass freely. The poles of these connected magnets are thereby closed, and cannot act on the disc; but the free magnetism excited in them by their coils is transferred through the iron stands E E to the open poles of the next magnets (which are like G G), so that the field of the latter will now have a double intensity. In this case all active poles on one side of the disc D are north poles, and on the other side south poles. The disc D is constructed of radial parts, P (Fig. 10), and of circular connecting parts, $R_{,} R_{,,}$ (Fig. 11), both of copper. The latter are bent correspondingly to the circle in which they rotate, and their ends are bent angularly, as shown in Fig. 11. The parts $P_{,} P_{,,}$ and $R_{,} R_{,,}$ are then connected together by soldering or otherwise, as shown in Figs. 12, 13, and 14, at the points *a*, *b*, and *c*.

A second similar circle is then made, with the parts $R_{,} R_{,,}$ shorter, so that it can be laid within the first one, without touching anywhere; the end *d* of the first circle is then connected to the second one at *d*. In the same manner are five (more or less) such circles connected, each one rather smaller than the other, narrow strips of insulating material being placed between at the ends, that the air may freely circulate between the parts. A current flowing in at the first end P I, must therefore circulate through all of these five circles, the last of which has no part, $R_{,,}$. Such a connection of 10 radial pieces P, and nine connecting pieces, $R_{,} R_{,,}$, is hereinafter called a segment. Of these there are 32. They are laid one in another, to form the disc, as is shown in Figs. 7, 8, and 9. One half of the segments are made shorter in the radial direction than the other half, which causes the formation of two rows of each of the parts $R_{,} R_{,}$ and $R_{,,} R_{,,}$ on each side of the disc, allowing them to better pass each other without touching. The radial parts P are held together by the flanges C (Fig. 1), and a ring, T, may be laid around the disc, as shown in Figs. 8 and 9.

Fig. 7A represents the outer circumference of the disc, supposed to be laid out flat, and explains how the different sections are connected so as not to interfere with each other. Only the outside row, $R_{,} R_{,}$, of the connecting pieces is to be seen. The angular distance *x y* (Figs. 7, 8, 9) must be equal to the angular distance from one magnet to the next—*i.e.*, to $\frac{1}{16}$th of the circle. Every section is consequently inducted at the same time by two pairs of magnets. The segments are connected to form four different circuits, in such a way that four consecutive segments belong to four separate circuits; each circuit consists, therefore, of eight segments and 80 radial parts, P. Every magnet acts at the same moment on four segments in one direction, and on four on the other. The inductions in the four circuits follow one another, so that while one circuit is in the best position, two others are only partially inducted, and the fourth is in a neutral position. Those segments having similar positions relatively to the magnets are connected in circuit by connecting pieces, which are not seen in the drawings, because they lie inside of the flanges C (Fig. 1). These connecting pieces are joined to the inner free ends of the first and last of the radial parts P, in each segment, and their direction and positions are shown for the series marked with the number 1 in Fig. 9 by the inner arches. The first and last end P of every circuit is, according to the system of connection used, joined either directly to the commutator or to the next circuit.

In order to better understand the induction, we may suppose there to be only a single circuit, so constructed that the inner parts $R_{,,}$ do not return on the left hand to the same section, as in Fig. 12, but towards the right, to the next magnet, as is represented by the thick zigzag line in the Figs. 15, 17, 19, 20, laid out flat. The pole pieces of one row of magnets are represented by shaded squares, and the directions of the molecular magnetic currents, according to the *hypothesis of Ampère*, by fine arrows. The directions of the currents inducted are marked by arrow heads, drawn on the zigzag line. The diagrams, Figs. 15 and 17, relate to the construction of the magnets according to the method *a*, previously mentioned. Fig. 15 shows the parts $P_{,} P_{,,}$ situated in the middle between the north pole *n*, and the south pole, *s*. In moving towards the right, the part $P_{,}$ retreats from the molecular currents of the south pole at its left side, which are directed downwards. This would induct in it a current of equal direction, but simultaneously $P_{,}$ approaches also towards the molecular currents of the north pole *n*, at its right side, which tends to produce a contrary current. Both inductions are opposed to one another, and therefore this position is neutral. $P_{,,}$ is *in every position* inducted exactly the same as P I, but in opposite direction.

In Fig. 17, P I is situated in the centre of the north pole *n*,

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retreating from all molecular currents at its left, which are directed downwards, and approaching those at its right side, which are directed upwards. Both of these actions induct in $P_{,}$ a powerful current in the upward direction, consequently this is the most active position. The next position will be again, like Fig. 15, neutral, and the second next, like Fig. 17, but in contrary direction. There are therefore during one revolution sixteen alternations of the current in all parts of the disc. When the magnets are arranged according to the method *b*, there will be only one half of the number of poles active, and these will be, on one side of the disc, all of the same sign. The disc remains exactly the same.

Fig. 15.

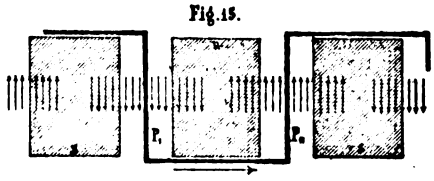
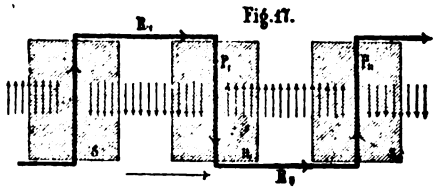


Fig. 17.



The position (Fig. 19) is now neutral. All poles are south poles. The directions of the molecular currents change, therefore, as well in the middle between two poles as in the central position between the north and south poles of arrangement *a*, and as P retreats from and approaches an equal number of molecular currents in a downward direction, no induction can take place. Fig. 20 is, like Fig. 17, the best position. There are as many alternations per revolution as in the arrangement *a*.

In consequence of the peculiar positions of the parts $R_{,} R_{,,}$ close to the inner and outer edges of the pole pieces (Figs. 1 and 8), there are useful currents inducted also in them in such directions that they will correspond with those inducted in $P_{,} P_{,,}$. In the position (Fig. 17) the molecular currents between the south and north poles are of such a direction that they flow away from the part $R_{,}$ while the latter is moving towards the right-hand side; this inducts, according to the laws

Fig. 19.

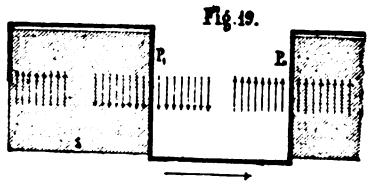
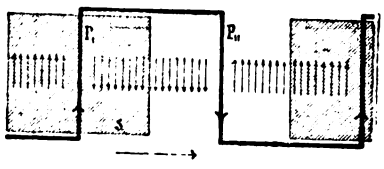


Fig. 20.



of induction in $R_{,}$, a current of equal direction with the motion of the latter and corresponding with that inducted in $P_{,}$ and $P_{,,}$. The same is the case in the part $R_{,,}$ and in all other parts $R_{,} R_{,,}$ belonging to the same circuit. When the disc has advanced $\frac{1}{16}$th of a revolution, the molecular currents flow everywhere *towards* $R_{,} R_{,,}$, which inducts a current in an opposite sense to the motion of the latter, corresponding again to the radial inductions then taking place. In the same way, induction takes place in those parts, $R_{,,}$, which pass, as in Fig. 12, towards the left hand side,

The commutator (Fig. 4) consists of eight rings, L, combined in pairs for each circuit, well insulated from each other. Each ring has eight projections, and they are put together so that the sixteen projections of each pair are exactly $\frac{1}{16}$th of a circle apart.

The sixty-four projections form the sections of the commutator, against which the positive and negative brushes are so adjusted that they touch simultaneously the projections of a pair of the rings. The contact surfaces of the brushes may therefore be 1, 3, 5 . . . . . to 15 sixteenths of the circle apart from each other.

The connections of the circuits with the commutator may be arranged in different ways. For currents of low tension each circuit may be led directly to the commutator, which connects it with the external circuit so long as its potential is higher than that of the main current, and cuts it out so long as the potential is lower. To secure a good action, the potential must be equal to that of the main current at the moment when the brushes make or break contact with the sections of the commutator, and to accomplish this the brushes are made in pairs, which can be adjusted so as to cover more or less of the sections of the rings. Two, and at some moments three, of the four armature circuits are at the same time connected to the external circuit. In this case it is of advantage to construct the pole pieces broad, as appears in Fig. 17. If a higher tension is desired, then the pole pieces should be narrow, so as to concentrate the field.

The circuits may also be combined in one single endless one, and branches taken from it to the commutator, according to the system Gramme. In this case the disc should be divided into more than four circuits, which may be accomplished by the arrangement shown in Fig. 7B, which contains seven separate circuits, each of which may be again divided into two, by transposing the magnets in the circle accordingly. The pole pieces should then also be made narrow, and fewer magnets be used (say 10 or 12 pairs), in order that the neutral places may be wider, to prevent sparks at the commutator.

To remove the shaft B with the armature easily, the stands E E are open at *e e'*. These openings are closed by segments, to which two or more magnets are fastened, and which are removed with the segment, if the shaft is to be lifted out.

AN ELECTRICAL VALVE.—This apparatus is designed to regulate the supply of heat to a room by the temperature of the room itself, and consists of a thermostat, on the principle of differential expansion, which can be set at any desired temperature at any time by anyone by means of a small set screw—an "electro-pneumatic valve," which is an ordinary electro-magnet of 6 ohms resistance, and which has attached to its armature a stem operating a tiny pneumatic valve. This valve, though perfectly double acting, has a play of only 1-32 of an inch. The apparatus is really worked by compressed air, which is forced into a tank 12in. in diameter and 15ft. long, by means of an automatic air-pump driven by water pressure, only consuming from five to ten gallons of water daily. This compressed air is led by means of common $\frac{1}{8}$in. brass tubing to every room in the house connected with the inlet of the electro-pneumatic valve in that room. Now, as long as the temperature in the room is lower than the thermostat is set, the circuit is open and steam is allowed to enter the coils. But the instant the temperature rises one-fourth of 1° over this point the circuit is closed, the electro-pneumatic valve is opened, and the compressed air allowed to flow into a diaphragm steam valve in the radiator, and the valve is seated by a positive piston motion and held in its seat by a force of from 100 to 150 pounds. This continues till the temperature falls one-fourth of 1°, when the circuit is broken, the electro-pneumatic valve closes against the compressed air reservoir and opens a vent for the air in the diaphragm valve, which, escaping, allows the valve to open and admit steam till again checked by a rise in the temperature as before. This system seems to remove the greatest objection to steam-heating.—*Electrical World*.

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THE ELECTRICIAN.

TO CORRESPONDENTS.

All communications to be addressed to 1, *Salisbury-court, Fleet-street, E.C. Those relating to Subscriptions, Advertisements, back numbers of the Paper, and so forth, should be addressed to the Publisher; and those relating to Articles, Correspondence, or Notes, to the Editor.*

All letters intended for insertion in THE ELECTRICIAN, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

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Advertisements intended for the current week's issue must be handed in not later than Thursday, 4 p.m.

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NOTICE.

With our present Issue is published the INDEX to Vol. XIV.

Also, as a Supplement, "The Exhibition Record."

(Subscribers should receive both gratis.)

ELECTRICAL PROGRESS.

The completion of another Half-Year's Volume of *The Electrician* offers a fitting occasion for reviewing the progress that has been made in electrical enterprise since last November. It may as well be confessed at once that the hopes with which we ended our previous volume have not been realised to the extent we had hoped, or electrical engineers had expected. But, perhaps, on that very account it may be useful to survey our present position and prospects.

As to the latter, the confidence which prevailed in 1884 remains unshaken. It is only in the matter of immediate and substantial results that there have been some disappointments. First, and chiefly, nothing has come of the efforts made to amend the Electric Lighting Act; though these efforts have no doubt had some effect in paving the way for the desired alterations, or for the abolition of the Act when a more convenient season shall arrive. Besides the important committee, which went thoroughly into the question and presented its Report, several influential bodies have petitioned the Board of Trade with a similar object; and, what is more, the extended sphere of electric lighting enterprise is steadily operating in the same direction.

Foremost amongst the agencies for promoting this object is, of course, the grand and varied displays of Electric Lighting at the Inventories Exhibition, some notion of the magnitude of which may be gathered from our Exhibition Supplement, which we propose to continue during the season. We shall give full details of the various exhibits interesting to our readers, as circumstances permit; but already we are glad to notify a general improvement in respect to some defects which we have formerly called attention to. Until recently there was a tendency among makers of Dynamos and Engines employed in electric lighting to fall into a groove of what may be called regulation patterns and sizes, just as though we could always count upon splitting up the work to be done into equal portions proportionate to the power "in stock," or could use it with economy where the power is in excess of the work to be done. Engines and dynamos should be ordered to suit the occasion, just as is the case with all other kinds of engineering. Of course there will always be regulation sizes in demand; but special conditions are so numerous and various that both engineers and makers should lay themselves out for designing and making exactly the kind and power of machinery required for the special work in hand, whether large or small, whether arc lighting or incandescent, or both.

Considerable business has been done in fitting with the Electric Light the ships of our mercantile marine; and this is a business sure to go on expanding. A very brisk demand has arisen in this department in consequence of the expected outbreak of hostilities, a great number of men-of-war having been fitted not only with the ordinary lighting arrangements, but with special appliances adapted for the purposes of warfare. It is now almost certain that the interpretation put upon these appliances by their makers will not be submitted to the arbitration of any impartial shell, foreign or native. But although the experiment would have been highly instructive, we cannot, perhaps, on other grounds, regret that it is not to be tried just at present. The lighting of a portion of the navy, however, remains a fact, and one which we expect to see largely extended.

Of independent installations on land, differing in this respect from the miscellaneous ones at the Exhibition, the most important is that at the Paddington Station and Hotel, to be completed, we believe, next month. Its results will be watched with keen interest by everybody interested in the practical and financial success of Electric Lighting on a somewhat unusual scale.

Turning to another branch of electrical industry, we have had a Parliamentary Committee taking evidence relating to overhead wires in the metropolis. The result of this inquiry is at present highly problematical, the interests concerned in maintaining these wires being extremely powerful, and the testimony in support of them so inaccurate, that we apprehend the worst, especially as the evidence on the other side, although conclusive enough, is half-hearted and comparatively small in bulk. Should, however, the Report recommend the laying of the wires underground it will be impossible to repeat in this country the farce that is being played in New York. Physicians of that city have been feed to certify that the opening up of the pavements would very likely give rise to an epidemic of cholera. As London streets are always in a chronic state of dissolution, either Londoners are impervious to cholera or there is no cholera in the composition of London pavement. We may thank the New York telephone companies for this lesson.

The Submarine Cable Protection Bill, which passed the House of Commons on Tuesday last, will throw a moral as well as a legal obstacle in the way of cable destroyers. It is something to have got the fact recognised that to wantonly, or even carelessly, disable a submarine cable is an offence against international law, and is punishable like any other aggression upon private property. Submarine Cable business is, on the

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whole, not in the most flourishing condition just now; for although the traffic consequent upon warlike operations—whether they be actual war or not—is very considerable, it hardly makes up for the loss of commercial traffic which these operations create. The public who are invited to find money for fresh cables should bear this fact in mind. No cable company, however advantageously situated, prefers a period of disturbance and war to one of peaceful and active trading; and this is not the time to project new submarine lines, unless for national purposes, and paid for by the nation. The system of coding, too, which has become quite a science among cable customers, has altered the conditions under which cable owners invested their money. Every fresh year's experience shows that the basis on which the tariffs were framed is not a remunerative one, now that the character of the traffic has undergone a complete change.

Down to the time of our going to press there was still some uncertainty as to whether the Postmaster-General's Bill for the introduction of sixpenny telegrams will be allowed to pass this Session. The threatened opposition to its abolishing the free addresses has grown into something rather formidable; but if Mr. Lefevre holds to his threat to withdraw the Bill if this provision is rejected, probably the objectors may be silenced.

CORRESPONDENCE.

PROF. FORBES' REPORT ON THE B.T.K. BATTERIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is extremely doubtful whether the Consolidated Electric Company have in any way advanced the merits of their B.T.K. storage battery by publishing Prof. Forbes' report of the tests he carried out with them, as it seems to be anything but satisfactory as regards their efficiency.

To commence with, the master cell seems only to act properly when a *certain rate of charge* is employed. Now, the present demand for secondary batteries is mainly, if not entirely, required for the lighting of private residences, either to overcome the unsteadiness of the motive power, or to have a store of electricity for possible night use after the engine has been stopped; and as the number of lights is continually altering, the rate of charge is proportionately increasing and decreasing, which will in its turn affect seriously, if not fatally, the proper working of the master cell. I have assumed in this case that the dynamo is running whilst the majority of lights are being used, this being the only true economical method of employing accumulators. Thus the master cell may be looked upon as not a success.

Then, as to the figures given of the charges and discharges, they are both scientifically and practically worthless, as there is absolutely no data whatever given as to the rate of either charge or discharge, the only item given being that the E.M.F. had fallen very low indeed; which at once stamps the two columns of figures as of no value whatever, as who would think of calling the discharge or "output" of a battery "useful" after the E.M.F. had fallen 18 per cent., though it may have fallen even lower than this? As Prof. Forbes says, "I discharged until the E.M.F. had fallen more than would have been convenient in practice;" and subsequently says that he considers a fall of 18 per cent. allowable. I think that only a fall, at the very outside, of 7 or 8 per cent. should be allowed in calculating the true commercial efficiency of a battery; so that the efficiency given as 60·23 per cent. should read something like 25 per cent. if the real facts of the case were known. Some designation, too, might have been given to these two interesting columns of figures, instead of leaving it to the imagination of the reader. I take it for granted that the figures given under the fifth discharge are accidentally inaccurate, otherwise the cells seem to have given out 70 per cent. more than was put into them at this stage, and this when corrected further very materially reduces Prof. Forbes' statement of the *true* commercial efficiency.

His next statement, that some of the cells lost their E.M.F. entirely, thus causing the efficiency of the battery to be lower than would otherwise have been the case, is worthy of attention, as he distinctly states that the only way to test batteries properly is by taking a number of cells in series, and not singly, so that his results must be taken as indicating what the battery is capable of doing in practice, and nobody wants to know what they should do, had they all remained in a theoretically perfect condition.

Prof. Forbes then goes on to say that some of the plates bulged; but this would not have been the case had the plates been properly used. Are we to understand, then, that he did not treat them fairly whilst testing them? Though this can hardly be the case, seeing that the rate of charge or discharge was strictly in accordance with what the Company themselves preferred to use, and they would hardly have given any other than that which gave the best results. I think that the bulging simply showed itself in the ordinary course of the working of the cells, and is anything but unusual with secondary batteries, this defect being one that has caused more trouble than all the other shortcomings put together, and it always will appear unless some special arrangement is made for preventing it. As to the test with the new set of cells, the same remarks apply to it also as regards the "practical output" being calculated by allowing the E.M.F. to fall *only* 14 per cent.

In conclusion, it would be satisfactory to learn for whose benefit the report has been so extensively published in its present form, whether for electricians or the general public. If it is for the former it is of no use whatever, as it gives no information that would be of service in determining whether or no the batteries could be relied upon in practice; though certainly, to judge from the opening paragraphs, it did give promise of being an accurate and detailed report, if we notice the careful way in which it is stated how accurately the measuring instruments were continually calibrated. But if it is meant for the general public it is more likely to frighten than inspire them with confidence in secondary batteries.—Yours, &c.,

F. GEERE HOWARD.

May 5, 1885.

THE INVENTORIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly allow me to correct a statement appearing in your issue of last Saturday regarding our exhibits at the Inventions Exhibition.

The Prince of Wales's Pavilion is not lighted by Swan lamps, nor from a dynamo (directly), nor is the dynamo driven by an Elwell-Parker high-speed engine.

We are using Woodhouse and Rawson lamps, which are fed from our accumulators arranged on the north side of the pavilion. These are charged by one of our dynamos in the daytime.

Our high-speed engine is used in connection with Mr. Holroyd Smith's electric tramway, and in our train-lighting plant shown at the Coalbrookdale Company's exhibit.—Yours, &c.,

P. BEDFORD ELWELL, Director,
For Elwell-Parker (Limited).

ELECTRICAL CONDITION v. RECENT SCIENCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It has been said on unquestionable authority that the word "energy" is of recent introduction into science, and we are now commonly told of "heat energy" and "electrical energy;" but my conviction is that no one is able clearly to define the meaning of energy as a scientific definition. It certainly will not stand the test of reasoning. Another word to which I am a stranger is "potential." "The difference of potential between two metals when in contact." But what can it mean? In 1847, as may be seen on reference to any chemical work of that or previous date, the zinc of the galvanic battery was positive and the copper negative. But in

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one of a series of papers I wrote in the *Chemist* from April to October, 1847, consecutively, I suggested that the plates when taken out of the battery indicated the condition of their respective atmospheres, which must be in an opposite condition to that of the plates themselves—that the zinc, in fact, was actually undergoing combustion, and must therefore be negative. It is true that science was deplorably led astray on the heat doctrine, but I do not remember an instance in which recourse was had to the possible in support of an argument.

In the several pages of this journal reference is made to "the electric light," as if electricity were the cause of light; and when I have seen a flash of lightning leave a cloud and illumine the atmosphere for miles around, I have been under the impression that it proceeded from electricity accumulated in the cloud. But in a review of a lecture delivered by Sir W. Thomson on the same theory, it is said "We have one of the best attempts to give a popular explanation of the wave theory of light since Prof. Tyndall delivered his course of lectures on light in the United States." To me the theory is utterly incomprehensible, and appears to be based on the assumption of an agent the presence of which has to be demonstrated, its performances actually bordering on the miraculous, as the following extracts will show :—

"Sir W. Thomson speaks of 400 million million, and says that some people told him they could not understand a million million, when he replied they could not understand that two and two make four. To him finitude is incomprehensible, while the infinite in the universe is comprehensible, for we cannot conceive an end of matter or an end of space. We can understand 1,000 per second as easily as we can one per second; and as there is no finitude, it is not impossible to conceive 400 billion vibrations per second; and when the luminiferous ether vibrates at that rate, the normal human eye perceives red light."

Now, one per second is naturally less than a healthy pulsation, but to count a thousand beats per second is, so far as I can comprehend, an impossible; and what relation there is between there being no finitude and the 400 billion vibrations of the luminiferous ether quite surpasses my comprehension.

"To move one's hand once per second requires but a very moderate force; to move it ten times in a second requires 100 times as much force, and for 100 vibrations per second 100,000 times as much force. Similarly, to move anything 400 billion times a second, a force would be required one billion billion times as great."

As Sir W. Thomson said, consider greatly what that number means, and what we are to infer from it. What force is there in space between the eye and the light? What forces are there between the eye and the sun or Sirius? There is matter and there is motion; but what magnitude of force may there be? "The luminiferous ether is the only substance," says Sir W. Thomson, "we are confident of in dynamics, and through that we can move as if it were nothing." We are then told that the luminiferous ether, according to Sir W. Thomson, is an elastic solid, and the nearest analogy he could find was to compare it to a bowl of jelly, with a little ball of wood floating in the middle, by means of which he imparted vibration to the jelly. He also compared it to shoemakers' wax, a large slab of which he placed in water with corks attached to the under surface, and bullets on the top. After dilating on what Sir W. Thomson believes, that the discoveries in electricity, the motions of comets, and the marvellous sparks of light from them, tend to show cracks in the luminiferous ether—that is, shows a correspondence between the electric flash and the aurora borealis, and cracks in the luminiferous ether—we are told that, "what is certain is the existence of an all-pervading medium, an elastic solid, with a great degree of rigidity, the rigidity being so great in proportion to its diversity that the vibrations of light have the frequency above mentioned." In no one instance, however, does Sir W. Thomson adduce a fact corroborative of this wave doctrine of light, nor of the existence of the luminiferous ether.

Professor Tyndall in "Heat a Mode of Motion," like Sir W. Thomson, speculates on the undefinable, and tells us that the heat developed by the stoppage of the earth in its orbit would be equal to that derived from the combustion of fourteen globes of coal, each equal to the earth in magnitude; and if after stoppage it fell into the sun, the heat would be equal to that of the combustion of 5,600 worlds of solid carbon. But, to pass from the improbable to the matter of fact, it is said that solid carbonic acid is cold enough to *burn the hand*, and that a piece of iron of equal coldness would do serious damage. Why cold "burns" does not appear, the fact being totally opposed to the heat doctrine; but on the principle of electrical condition, as explained in my letter at page 455, the effect is produced by the combination of the oxygen and hydrogen of the flesh to the production of water, the electricity of both the acid and iron being in excess, or free. It is then demonstrated that if the solid acid be placed on the thick portions of ordinary tumblers or drinking glasses, and the acid be wetted with ether, the glasses are shattered by "the contraction produced by the intense cold;" whereas I contend that the effect is produced by evolution of free electricity, which electricity would travel through a wire to a hot solution, which cold—that is, the normal cold of a body—will not do." In this basin I spread a little paper, and over the paper I pour a pound or two of mercury; on the mercury I place some solid carbonic acid, and on the acid I pour a little ether. Mercury, you know, requires a very low temperature to freeze it; well, here it is frozen."

Connected with frozen mercury there are two facts that demand consideration. In the northern, but more especially the Polar regions, the mercury of thermometers freezes, and the temperature of the atmosphere is assumed to be equally cold. But if the bulb of a thermometer be moistened with ether, or even with strong spirits of wine, the temperature decreases with each application; and on the exposure of a thermometer to a very cold atmosphere it gradually descends to the freezing point of the mercury, and that is assumed to be the actual temperature of the air. I have suggested, on the evidence of facts, that a vacuum is highly electrical—may, in fact, be a representative of space. It is not improbable, then, that in the freezing of the mercury of the bulbs of the thermometers the vacuum may be an important factor; and I am not aware of any experiment having been made with two thermometer bulbs—one a vacuum and the other not. In the above detailed experiment of the freezing of "a pound or two" of mercury with *some* solid carbonic acid moistened with ether no cognisance is taken of relative proportions.

All the above facts have a direct bearing on the cause of intense cold, and if a lump of frozen mercury be placed in front of one of a pair of mirrors, it is said that a delicate thermometer in the focus of the other gives evidence of heat; in reference to which fact M. Pauillit avers that the thawing mercury actually gives out heat. A red hot cannon ball, similarly placed, we know will ignite tinder in the focus of the second mirror, and this action is assigned to the heat given out by the red hot ball. But heat has an expanding influence on air, and the ascending air could not otherwise than prevent any of it reaching the second mirror. If, however, we assume the incandescent iron to be surrounded by an atmosphere electrical in proportion to the incandescence, the electricity would readily travel to the mirror, and, by producing in the focus a high electrical atmosphere round the tinder, cause ignition, as the free electricity given off from the thawing mercury produces the apparent influence of heat on the thermometer, which, I presume, is not a mercurial one.

On a previous occasion I have stated that during combustion hydrogen has a much greater affinity for oxygen than carbon has, and this principle is most beautifully illustrated in the production of artificial light, whether from a candle, gas, or mineral oil. In contemplating a candle we see round and above the wick a bluish translucent cone, above which and around it is an incandescent opaque mass or cone producing the light, and this without doubt is surrounded by an electrical medium, proportional to the incandescence. But Professor Tyndall, in the work already referred to, avers that the bluish flame, like burning hydrogen, and its surroundings are "unburnt vapour within, common air without, whilst between both is a shell which forms the battle ground of the clashing atoms, where they develop their light and heat," which light

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and heat to be developed must be in the materials in a latent state. The chemical action of course goes for nothing.

On a *red hot* silver basin being placed on hot water, the basin does not touch the water but maintains a space underneath, the fact being accounted for because "the basin for a time develops a sufficient amount of vapour underneath it to lift it entirely out of contact with the water; or, in the language of the hypothesis developed in our third picture, it is lifted by the discharge of molecular projectiles against the under surface." But what causes the molecular projectiles does not appear; the red hot basin and its electrical atmosphere being clearly the factor. If, however, the basin be reversed and made hot by placing the spirit lamp underneath it, "every drop, as it strikes the hot surface, and as it rolls along the surface, develops vapour, which lifts it out of contact, thus destroying all cohesion between the surface and the drop, and enabling the latter to preserve its spherical or spheroidal form;" but on this heat doctrine the vapour should dissipate the drop. On the leaves of many plants, but more especially the blades of grass and of wheat, the drop of dew retains its spherical form without being lifted out of contact, a fact to which my attention was forcibly directed in 1853, when having passed through a piece of potatoes dry footed, on entering a piece of grass my stockings became sopped. I therefore retraced my steps, and then found that the potato leaf absorbed the moisture, whilst the grass did not, but without doubt evolved electricity.

At page 212 of this work there is detailed a very beautiful experiment, consisting of an incandescent lamp, acted upon by a galvanic battery through a coil of wire, having in the middle of it two feet of platinum wire, which necessarily becomes red hot; and the wire in so becoming red hot deadens the light. But on its being bent and plunged into a basin of water, the lamp increases in splendour proportionally to the immersion of the platinum wire. Does, then, the water alter the nature of the wire, or does it become a conductor of the fluid? On the circuit being broken by the fusion of the two feet of wire, *when surrounded by air*, the lamp, as a matter of course, went out.

In the next page the question is asked, "Are we to suppose the cold to be an entity?" and it is answered in the negative, "No." But from the time of putting the question to the present, electricity has been gradually growing to an "agent" and a "fluid," to, of course, the validity of the cold doctrine, and exclusion of the heat ones. And a platinum wire is fused by a current, when surrounded by air, but becomes a good conductor when surrounded by water!—Yours, &c.,

FRANKLIN COXWORTHY,
Author of "Electrical Condition" of 1848.

PROFESSOR TYNDALL ON THE SOURCES OF ELECTRICITY.

The fifth lecture was delivered on the 6th of January. At the outset, Professor Tyndall said that some years ago he endeavoured to put in the smallest possible compass a quantity of knowledge regarding electricity, and the work was published by Messrs. Longman. Those gentlemen had been liberal enough to allow him to have 500 copies of this little *brochure* on very moderate terms; but, as he had the honour of speaking to an audience of more than 500, he had thought it better to wait until the last lecture in order to keep them all on the same level, and then distribute them all at the same time. On the next occasion, therefore, some of them would be able to take away with them a little reminder of what they had heard during the lectures. Resuming his lecture, he said that he had placed before them a series of electric cells and an electric battery—that was, single cells and a battery devised by his friend Sir William Grove. Calling attention to a plate of platinum and a plate of zinc, he said that they were immersed in liquid. If they examined the screw which he indicated, they would find positive electricity on one side and negative electricity on the other; and, if he united one screw to the other, they would have a flow of electricity from screw to screw, the positive flowing in one direction and the negative in the other. They agreed to call (and he wished them to understand that it was a mere arbitrary agreement to do so) the direction in which the positive electricity moved the direction of the current. Uniting screw to screw by a wire or conductor, he stated that there was a current of electricity flowing from one side to the other. Mr. Cotterell had placed there a piece of platinum wire, and he would connect this wire to this cell. Passing on from this point he called their attention to a single cell, which he said at that moment had no power. There was a platinum wire, and a current was flowing there through a thin platinum wire that spanned the space from wire to wire, but the current coming from the single cell was too feeble to raise the wire to incandescence. Directing their attention to a battery, which he described as a collection of cells, he stated that exactly as in the case of the Leyden jar they had the single Leyden jar and the battery of Leyden jars, so now they had the single cell and the battery of cells. If they examined the five cells before him in a proper electroscope they would find the strength of electricity (at points indicated) exactly five times the strength of the single cell. He would now show them a battery of ten cells. They would find the force with which the electricity tended to burst from the cell was in direct ratio with the number of cells. Now, Mr. Cotterell would show them that this ten-cell battery had power to produce effects very much greater than the single cell. Mr. Cotterell would make the connection, and they would see that what the single cell could not do the ten cells did, and they saw the wire in a state of incandescence [experiment]. They had a battery downstairs with fifty of these cells, and he wanted to direct their attention now to a point of very great importance in connection with the flow of the electric current. If the electric current encountered no resistance in its passage they could have no heat. It was because the platinum wire refused to allow the current to pass through—because there was a conflict between that and the current—that the conflict produced the incandescence. If he placed another wire there they would see no heat at all, because in a wire producing no heat there would be little or no resistance, and hence the philosophy of the electric conductor. They saw these conductors on churches and other buildings. If the discharge struck a chimney without a conductor the chimney was shattered. He now showed them a rather long wire, and pointed out that it was red hot. He wanted to show them, in these experiments with regard to the point of resistance, that the current rose up, so to say, an enemy in its own path. If he chilled a portion of the wire when the current was passing through, a greater amount of electricity would flow through the chilled portion, and that greater amount ought to raise the remaining portion of the wire—the portion unchilled—to a higher state of incandescence. [Experiment showing this.] Electric light and electric heat were very powerful elements, the most powerful they could command. Mr. Cotterell would now give him a pair of carbon points. Carbon was a substance first used by Davy in that institution to obtain his great electric light. He had his two thousand pair of plates, and he produced with this a light four inches long. As the battery before them augmented in its number of cells the electricity became sharper and sharper. The most sensitive boy present could not feel anything from a single cell, but coming up to fifty the heat was rather sharp, particularly if one's fingers were wet. With five hundred cells they approached more and more to the electricity of the machine. The greater number of cells they added to the battery the more they approached the electricity of the machine. Exhibiting a wire, he said he would now show them the wondrous electric light that was shown in 1810 by Davy with his two thousand plates. [Experiment.] If he brought the two wires together under the water they would see the effect. [Experiment.] He would now ask Mr. Cotterell to put a steel file to one of the poles connected to one of the wires. He held now a steel file; he had one of the carbon points and brought them together, showing the power produced by the current. He described this as a beautiful experiment, the file being utterly dissipated in a shower of sparks. He now wished to hark back for a short time to a point illustrated rather fully in the last lecture—the subject of electro-chemistry. He would take two plates of platinum which were perfectly free out of the blue liquid before him, which was a solution of sulphate of copper. He would ask Mr. Cotterell to make a contact [experiment], and they would see that the wondrous electric current had torn the copper from its combination, and the copper was deposited on the surface of the liquid. The two plates were now no longer the plates they were when they were put in the liquid. If he now made use of the two plates he obtained virtually two metals, one copper, and one platinum. If he connected the two together he would get a strong current of electricity, from the one to the other, and in all cases where that occurred the current that flowed through these newly-created metals was always in an opposite direction to that which had produced the precipitation of the metal. All our electric accumulators, as they were called, depended simply upon this principle. They must not imagine that electricity was a thing to be obtained stored up in boxes as water was. The accumulator depended upon the principle they had just seen elucidated. They took two pieces of lead, and here Planté took the first great step, and communicated it to the Academy of Paris, and that had been improved upon by

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Faure and Sellon. The two currents were utilised to a great degree. [Experiment.] What he wanted them to understand was the principle of the thing. They took a number of cells—and, instead of platinum, pieces of lead—and they sent a current through those cells from an external source. The plates of lead were altered so as to make them different from each other, and they were converted virtually into two metals. This secondary battery could then be used to produce electricity. He was told that the battery (exhibited) had been used several times on the Thames on boats. Displaying a smaller one, he said it was intended to be carried in the pocket, and the jet of light produced was meant for a breast pin. He understood that similar batteries were employed by ladies on the stage to produce a light as a sort of ornament in their hair. Before quitting the subject of electro-chemistry there was one point he would mention, a point brought forward and emphasised very strongly by Faraday. They had seen the powerful battery which had been exhibited there. Faraday operated on the battery, and many a time he (the lecturer) had himself used it. They saw that an electric current had the power of deflecting a needle, and Faraday sent a current from the battery into a magnetic needle. He took two very thin wires, one platinum and the other zinc, one-thirteenth of an inch in diameter. He dipped these wires in acidulated water, the depth of immersion being only five-eighths of an inch, and he allowed them to be there one-seventh of a second, and during that time those two wires produced a greater effect than the machine of 28 tons which they saw in the previous lecture.

They must now go further into the relationship between electricity and magnetism. In 1820 the deflection of the magnetic needle was noticed by Oersted, of Copenhagen, and an account of the investigation was given of that in Geneva, and thence it went to the Academy of Sciences, in Paris. There was at that time in Paris a great scientific man, and a man of wonderful character corresponding with his greatness of intellect—Ampère; and in a single week he laid the foundation of what was called electro-magnetism. One new discovery by Ampère was that electric currents flowing in the same direction attracted each other, and electric currents flowing in another direction repelled each other. Calling attention to what he described as "an arrangement of the kind," the lecturer displayed a bent wire; and, dipping one wire into a cup of mercury, and another dipped into a little cup containing mercury, he said if they connected the two cups the currents would flow to and fro in opposite directions. [Experiment.] If he simply turned his hand and reversed the direction of the current, they had a repulsion. The currents were now flowing in an opposite direction, and, if he turned it upside down, they ought to have attraction. They could see it, though it was very feeble. He had suspended two spirals of wire through which he could send a current, and the stronger the current the better. Mr. Cotterell would connect the wires from the spirals to the instrument indicated, which was called the current reverser. He wanted to show them that the principle of attraction and repulsion was also manifested. He could send a current through these two wires which would flow in the same direction to the coil. When that was so, the ends of the coil would go thus together. [Experiment.] By reversing the current they had attraction and repulsion. [Experiments.] He wanted to show them next that they could get magnetic action, as Ampère had shown, without any magnet whatever. [Experiment.] He wanted to get two spirals into the circuit. [Experiment.] The motion they saw was due to the action of the earth's magnetism on that spiral. He would reverse the current, reverse the polarity—and he would not be surprised if it came back again. He would reverse the current and stop the motion towards him. They had another spiral, and if he brought it to one end of the coil they had repulsion. In that way Ampère imitated by means of electric currents all the actions of a magnet. He would now give them one or two more experiments in connection with the relationship of electricity and magnetism. The matter was gone into after Ampère's time by other scientific men, and they came to the conclusion that they must be able to obtain rotation—rotation around the current and rotation around the magnet. Faraday wrote an article on the electro-magnet. In doing so he had to read all that Ampère had written, and he became so impressed with the idea that he could get rotation that he tried and succeeded in obtaining rotation round a magnet and rotation round a current. [Experiment.] Mr. Cotterell would throw the shadow on the screen, and they would see the motion. The moment he made the connection they would observe the rotation. They could now see the magnet rotating around the current, and by reversing the current the motion would be stopped and would go in an opposite direction, and they now saw a rotation of the current around the magnet. There were various other experiments which he might show them connected with the relationship of electricity to magnetism; but he would now pass on and come to one of the other sources of electricity. He had before him some instruments which would enable him to illustrate this other source of electricity. It was discovered by Seebeck, of Berlin, he believed, in 1826. He held, as they could see, two metals soldered together. One was bismuth and the other antimony. In front of him was the magnetic needle. He would act on that magnetic needle, and make it their tell-tale as to the existence of an electric current. Connecting the bismuth and antimony with the needle, he stated that an electric current was produced by contact at the junction of the bismuth and the antimony, which would make itself evident on the needle. [Experiment.] There they had a new source of electricity. He wanted to make a battery of a pile, and he united the bismuth and antimony rods together. If they wanted to augment the strength of the action they united the rods together, and then they had a thermopile. He connected it, as before, with the galvanometer. If he simply touched this pile with his finger they would see its extreme sensitiveness. [Experiment]. Mr. Cotterell wished to bring the needle to zero, but as long as one place was warmer than another there would be an electric current. [Experiment.] It crossed to zero, and went up to 90 degrees on the other side. Calling their attention to a reflector, he observed that he had devoted some ten or twelve years of his life working at this thermo-electric pile. They saw its extreme sensitiveness. It was at first presented by an Italian savant, and afterwards worked at by an illustrious Italian named Melloni. The instrument before them was Melloni's thermopile, and the reflector which he (the lecturer) had placed on it was silvered within for the purpose of concentrating on the face of the pile very feeble radiation of heat. He might say that this thermo-electric pile was mainly due to investigations on radiant heat. The young gentleman who had been experimented on before would now assist him, and they would see, if his cheek were warm, what the effect would be on the pile. [Experiment.] His cheek was warm, and the pile was going up. Taking a piece of ice, he said they would see what occurred through the agency of a cold body instead of a hot. The needle would come down. [Experiment.] The needle would pass over the zero line, and would go up the other side. There was a very great man at the beginning of this century who founded that institution, Count Rumford. He was led to believe that there were rays of cold just as well as rays of heat, and he figured to his mind the rays of cold passing through and chilling the pile. The pile became a warm body in comparison with the ice; the heat absorbed the ice, and in that way the pile became chilled and they got action due to the chilling. It was always very necessary to augment the delicacy of their instruments; and that was done with regard to the electric current by the galvanometer of Sir William Thomson. It was simply a suspended magnet. The one before them was small and it moved to and fro by that action. He had had presented to him a bismuth and copper plate, and if he heated one side of it they would see how the needle, which was between both, came out. [Experiment.] There was one experiment more he wanted to show them with crystal of tourmaline, which had been a source of perplexity and mystery to a great many. It was found that it possessed electric properties — properties like rubbed amber. It possessed the property of attracting light bodies. It required to be heated in order that its effect should be shown. He would now place the crystal into the flame of the spirit lamp. The perplexity arose from one person observing one effect and others other effects from the crystal. If he brought it to bear on the needle they would see that the needle was strongly attracted by it. What occurred was this:—In the investigation into the subject of this crystal of tourmaline it was found that sometimes one had at one end positive and sometimes at the other end positive, and the most diverse statements were made. When it came to a normal temperature there was no attraction, but when there was heat they had attraction, and they also had attraction while the heat was diminishing. This was a sample of what he called pyro-electricity. They had had, first, friction, then voltaic, next (that day) thermo, and now he had given them a sample of what he called pyro-electricity. He concluded by observing that he might go on showing them that the power they had just seen was possessed by other crystals besides crystals of tourmaline.

ON THE CHANGES PRODUCED BY MAGNETISATION IN THE LENGTH OF RODS OF IRON, STEEL, AND NICKEL.*

BY SHELFORD BIDWELL, M.A., LL.B.

The earliest systematic experiments on the effects produced by magnetisation upon the length of iron and steel bars are those of Joule, an account of which is published in the *Phil. Mag.* of 1847. Joule's experiments have many times been repeated, and his general results confirmed. In particular, Prof. A. M. Mayer carried out a series of very careful observations with apparatus of elaborate construction and great delicacy. The conclusions at which he arrived were in accord with those of Joule, so far as regards iron. In the case of steel there was some apparent discre-

* Abstract of a Paper read at the Royal Society, April 23.

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pancy, which, however, might to a great extent be accounted for by differences in the quality of the metal used, and in the manner of conducting the experiments. In 1882 Prof. Barrett published in *Nature* an account of some experiments which he had made, not only on iron, but also on bars of nickel and cobalt, with the view of ascertaining the effect of magnetisation upon their length.

The knowledge on the subject up to the present time may be summarisd as follows :—

1. Magnetisation causes in iron bars an elongation, the amount of which varies up to a certain point as the square of the magnetising force. When the saturation point is approached the elongation is less than this law would require. The effect is greater in proportion to the softness of the metal.

2. When a rod or wire of iron is stretched by a weight, the elongating effect of magnetisation is diminished ; and if the ratio of the weight to the section of the wire exceeds a certain limit, magnetisation causes retraction instead of elongation.

3. Soft steel behaves like iron, but the elongation for a given magnetising force is smaller (Joule). Hard steel is slightly elongated, both when the magnetising current is made and when it is interrupted, provided that the strength of the successive currents is gradually increased (Joule). The first application of the magnetising force causes elongation of a steel bar if it is tempered blue, and retraction if it is tempered yellow ; subsequent applications of the *same* external magnetising force cause temporary retraction, whether the temper of the steel is blue or yellow (Mayer).

4. The length of a nickel bar is diminished by magnetisation, the maximum retraction being twice as great as the maximum elongation of iron (Barrett).

In order that the results of Joule and Mayer might be comparable with those obtained by the author, he made an attempt to estimate the magnetising forces with which they worked. From data contained in their paper it was calculated that the strongest magnetising force used by Joule was about 126 units, while the strongest used by Mayer did not on the highest probable estimate exceed 118 units. In the author's experiments the magnetising force was carried up to about 312 units. The metal rods, too, were much smaller than any which had been before used for the purpose, ranging in diameter from 1·40 to 6·25 mm. Their length was in every case 100 mm., and the apparatus was capable of measuring with tolerable certainty an elongation or retraction equal to a ten-millionth part of this length.

By using thinner iron rods and greater magnetising forces than those previously employed, the following curious and interesting fact was established. If the magnetisation be carried beyond a certain critical point, the consequent elongation, instead of remaining stationary at a maximum, becomes diminished, the diminution increasing with the magnetising force. If the force is sufficiently increased, a point is arrived at where the original length of the rod is totally unaffected by magnetisation ; and if the magnetisation be carried still further, the original length of the rod will be reduced. It also appeared that the position of the critical point in steel depended in a very remarkable manner upon the hardness or temper of the metal ; considerable light is thus thrown on the apparently anomalous results obtained by Joule and by Mayer. Further experiments disclosed strong reason for believing that the value of the critical magnetising force in a thin iron rod was greatly reduced by stretching ; this would explain the fact that Joule obtained opposite effects with stretched and unstretched wires.

By ascertaining the relative values of the temporary moments induced by gradually increasing external magnetising forces, an attempt was made to connect the point of maximum elongation with a definite phase of the magnetisation of the several rods in which the elongation had been observed.

Though more experiments must be made before it is possible to generalise from them with perfect safety, the results so far obtained by the author indicate the laws given below. The elongations and magnetisations referred to are temporary only ; before the beginning of an experiment the rod was permanently magnetised by passing through the magnetising coil a current equal to the strongest subsequently used. In iron the greatest elongation due to permanent magnetisation was generally found to be about one-third of the total elongation, while in nickel the permanent retraction amounted only to about one twenty-fifth part of the whole.

I. *Iron.*

1. The length of an iron rod is increased by magnetisation up to a certain critical value of the magnetising force, when a maximum elongation is reached.

2. If the critical value of the magnetising force is exceeded, the elongation is diminished until with a sufficiently powerful magnetising force the original length of the rod is unaffected, and if the force is still further increased, the rod undergoes retraction. Shortly after the critical point is passed, the elongation diminishes in proportion as the magnetising force increases. The greatest actual retraction hitherto observed was equal to about half the maximum elongation, but there was no indication of a limit, and a stronger magnetising force would have produced further retraction.

3. The value of the external magnetising force corresponding to maximum elongation is for a given rod, approximately equal to twice its value at the "turning point."

Definition.—The turning point in the magnetisation of an iron bar is reached when the temporary moment begins to increase less rapidly than the external magnetising force.

4. The external force corresponding to the point of maximum elongation increases (when the quality of the iron is the same) with the diameter of the rod. So also does its value at the turning point.

5. The amount of the maximum elongation appears to vary inversely as the square root of the diameter of the rod, when the quality of the iron is the same.

6. The turning point, and therefore presumably the point of maximum elongation, occurs with a smaller magnetising force when the rod is stretched than when it is unstretched.

II. *Steel.*

7. In soft steel magnetisation produces elongation, which, as in the case of iron, increases up to a certain value of the magnetising force, and afterwards diminishes. The maximum elongation is less than in iron, and the rate of diminution after the maximum is passed is also less.

8. The critical value of the magnetising force for a steel rod diminishes with increasing hardness up to a certain point, corresponding to a yellow temper ; after which it increases, and with very hard steel becomes very high. There is therefore a critical degree of hardness for which the critical magnetising force is a minimum ; in steel of a yellow temper the value of the critical magnetising force is lower than in steel which is either softer or harder.

9. In soft steel a strong magnetising force subsequently diminished may cause a greater temporary elongation than the diminished force is capable of producing if applied in the first place.

10. A temporary elongation when once produced in soft steel may be maintained by a magnetising force which is itself too small to originate any perceptible elongation.

III. *Nickel.*

11. Nickel continues to retract with magnetising forces far exceeding those which produce the maximum elongation of iron. The greatest observed retraction of nickel is more than three times the maximum observed elongation of iron, and the limit has not yet been reached.

12. A nickel wire stretched by a weight undergoes retraction when magnetised.

PROGRESS IN SOUTH AUSTRALIA.

From a comprehensive report on the Post Office, Telegraph, and Observatory Departments of South Australia, by Charles Todd, C.M.G., F.R.A.S., Postmaster-General, Superintendent of Telegraphs, and Government Astronomer, which has recently been issued, we extract the following :—

The Telegraph Prior to 1870.

In December, 1855, the first Government telegraph line in the colony—Adelaide to Port Adelaide—was commenced, and on February, 1856, the line was opened for business, and was extended to Lefevre's Peninsula early in the succeeding month, the total cost, including erection of stations at the Port and semaphore, being £3,024.

The line was carried underground from the Port to the semaphore, and from the Adelaide Railway Station to the central office in King William-street. The underground cables consisted of six gutta percha double-coated copper wires, with an outer serving of tarred yarn, laid at a depth of two feet, in Henley's split pipes, a six-wire submarine cable (a remnant of the first Mediterranean cable) being laid under the river at the Port. Along the Port Railway the wires were overhead on square poles of Western Australian jarrah and Singapore cedar ; and it may be of interest to state that these poles are only now (1884) being taken up, having been replaced by much longer poles. The instruments selected were the Henley magnetic double needle, which were ultimately superseded by the Morse system, as the telegraph was extended to the other colonies.

It may be amusing to mention that the first day's receipts were 5s. 3d., the second 2s. 6d., the third 1s. 9d., and the fourth 1s. 3d.—totals certainly not calculated to inspire much confidence in the financial success of the infant scheme. It should, however, be stated that a rival line, erected by Mr. Jas. Macgeorge, had been opened between Adelaide and the Port immediately prior to the completion of the Government telegraph, and this secured for a time a large amount of public patronage. This line was ultimately purchased of Messrs. Elder, Stirling, and Co., for £80, and pulled down.

The business, however, steadily increased, and by the end of the year 14,738 messages had been transmitted, yielding a revenue of £366 6s. 7d.

A line of two wires to Gawler, including a branch to the Labour Prison, 28¼ miles, and costing £1,576, or a little over £55 per mile, was opened on April 14th, 1857 ; and that year there were 35,792 messages, yielding £1,183 13s. 10d., the receipts on the Port line being £883 17s. 2d.

In July, 1856, a scheme was submitted for an intercolonial line of telegraph between Melbourne and Adelaide, estimated to cost £20,500, and this amount being approved by the Government, the necessary provision was made on the Estimates for 1857. The actual cost of the line was £19,403 9s. ; it was commenced in April, 1857, and opened through to Melbourne on the 21st July, 1858. The route selected was *vid* Goolwa, and thence to Pelican Point, at the entrance to the Coorong, a submarine cable being laid across the Goolwa Channel and Lake Alexandrina. This cable gave much trouble, and was ultimately abandoned, the wire being taken by way of Strathalbyn and Wellington, after a second wire had been erected by that route in March, 1861.

At this time (1858) the telegraph had made only a beginning in New South Wales, a short line to the South Head being opened in January. Melbourne and Sydney were connected by telegraph on October 29, 1858, and Brisbane not until November, 1861. The telegraph was introduced into Tasmania

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in 1859, and in the month of August that year a cable was laid across Bass Straits in four sections, viz. :—

From Parker River to Victoria Cove, King's Island	49 miles
From Sea Elephant Bay, King's Island, to Three Hummock Island	50 ,,
Three Hummock Island, to West Bay, Circular Head	25 ,,
Circular Head to Low Head, near the mouth of the Tamar	72 ,,
	196 ,,

with intermediate connecting land lines across King's Island, Three Hummock Island, and Circular Head. This cable had a very short life of a few weeks only ; and it was not until a second cable was laid from Cape Schank to Low Head, in May, 1869, that Tasmania was permanently connected with the telegraph system on the mainland.

The telegraph was introduced into the several colonies as under :—

Victoria.—March, 1854, line to Sandhurst and Williamstown.
South Australia.—February, 1856, and a few weeks earlier by Mr. Macgeorge's line to Port Adelaide.
New South Wales.—January, 1858, line to South Head.
Queensland.—April 10, 1861.
Tasmania.—August, 1859.
New Zealand.—July, 1865.
Western Australia.—June, 1869, a private line from Perth to Fremantle taken over by the Government in April, 1871.

At first there was but one intercolonial wire ; but in 1859 the pressure one this was so great that a second wire became a matter of immediate necessity. This was completed by the end of 1861, the duplicate wire taking the route *vid* Wellington ; and about the same time a second wire was also put up between Melbourne and Sydney.

It was not until 1st May, 1867, that through communication between Adelaide and Sydney was established by the erection of a direct line. Communication, however, between Adelaide and Wentworth had been effected since August, 1866.

In the meantime the telegraph in South Australia had been extended to Kapunda, Clare, Kooringa, the new mining centres at Kadina, Wallaroo, and Moonta, Port Augusta, and other places.

The number of offices in South Australia at the end of 1869 was 63 ; length of line, 1,113 miles ; length of wire, 1,642 miles ; and the expenditure on lines and instruments, &c., to December, 31st, 1869, amounted to £101,591 10s. 3d.

The post and telegraph departments were amalgamated on January 1st, 1870 ; and from that date have been dealt with as one department.

In regard to the revenue and expenditure, the following comparative statement will show the growth of the telegraphs during the period 1870-83 :—

Telegraph.	1870.	1883
Number of offices	73	179
Length of lines (miles)	1,183	5,161¼
Length of wires (miles)	1,718	8,293¼
Number of telegrams (Colonial and Intercolonial)	128,485	653,119
Receipts from ditto	£10,649 16s.	£42,603 11s. 7d.
Number of International telegrams	—	43,334
Value of ditto	—	£251,277 19s. 8d.
Receipts due to South Australia	—	£27,510 5s. 7d.
Total telegraph revenue	£10,517 14s. 3d.	£75,877 3s.

The Port Darwin line was opened for traffic on August 22nd, 1872 ; but cable communication was interrupted from June 23rd till October 21st, when through communication with England was established.

Of the several schemes for extending telegraphic communication to Australia, the first was that submitted by Mr. Francis Gisborne, who visited Australia in 1859. The promoters he represented proposed to lay a light cable from the east end of Java, in five sections, to Moreton Bay—3,780 knots, including slack, at an estimated cost of £800,000. The colonies were either to take over and work the cables themselves, or guarantee to supplement the net receipts up to 6 per cent. on the capital outlay. After considerable negotiations, the Victorian Legislature passed resolutions in 1860, agreeing, under certain conditions, to a subsidy limited to £13,000 ; and New South Wales similarly agreed to a subsidy of £9,625.

The cable was to be of the same type, but rather heavier, than that first laid in the Red Sea, or, rather, between Suez and Bombay ; but that cable, like the first laid under the Atlantic, soon came to grief ; and, as a matter of fact, although the negotiations were continued by Mr. Gisborne and his co-promoters for several years, nothing was done.

In 1862 a prospectus was issued by the promoters of the Anglo-Australian and China Telegraph for a system of cables to connect Rangoon, Singapore, and Hong Kong, Java, and Moreton Bay, at an estimated cost of £2,080,000. The Australian Colonies were asked to guarantee a subsidy of £50,000 per annum for thirty years.

In March, 1870, a letter, dated 22nd June, addressed to the Governor, was received from Admiral Sherard Osborn, R.N., managing director of the Telegraph Construction and Maintenance Company, enclosing a prospectus of the British-Australian Telegraph Company, and stating that his company had received orders from the latter to manufacture a cable and construct a land line to connect Singapore and Burketown, the then proposed terminus of the Queensland telegraph system ; but as a portion of such land line from Port Darwin, where the cable was to be landed, would pass through the northern territory, Commander Noel Osborne, R.N., as agent for the company, was to be sent out to seek the sanction of the South Australian Government for the execution of these works. In reply the company were informed that, whilst every facility would be afforded to Commander Osborn, the Government would much prefer the construction of a telegraph line from Port Darwin to Port Augusta, then our most northern station, and that, with this view, they were prepared to submit to the Legislature a measure to authorise the entering into an agreement with the company for a direct line across the continent to Port Darwin, to be erected either by the company, under a Government guarantee, or constructed and worked by the Government.

It was finally determined that the Government should undertake the construction of the line to Port Darwin, to be completed by 1st of January, 1872, and the company agreed to lay and complete by the same date a cable from Singapore to Batavia, and from Banjoewangie to Port Darwin, the two sections to be connected by an intermediate land line through Java, to be constructed by the Government of Netherlands India.

A Bill was accordingly introduced and passed, authorising a preliminary loan of £120,000 for the land line.

The Government further undertook to provide a site for the cable company's office and quarters for staff at Palmerston, and agreed to erect the buildings at the expense of the company.

The following is a table of the distances in miles of the sea and land lines now connecting Australia with England :—

Falmouth to Gibraltar, *vid* Lisbon (sea)	1,250
Gibraltar to Malta (sea)	981
Malta to Alexandria (sea)	819
Alexandria to Suez (land line)	224
Suez to Aden (sea)	1,308
Aden to Bombay (sea)	1,664
Bombay to Madras (land)	600
Madras to Penang (sea)	1,213
Penang to Singapore (sea)	381
Singapore to Batavia (sea)	560
Batavia to Banjoewangie (land)	480
Banjoewangie to Port Darwin	970
Port Darwin to Adelaide, S.A. (land)	1,975
Total	12,425
Total length of cable	9,146
Total length of land lines	3,279
Total	12,425

ROYAL COLONIAL INSTITUTE.

At a recent meeting of the Royal Colonial Institute a paper was read by the Hon. Mr. Justice Pinsent, D.C.L., on "Newfoundland," from which we extract the following :—

"I am here reminded of the debt in reference to oceanic telegraphy which the world owes to our modest and (except when required as an inevitable necessity) neglected colony. The germ of the system of ocean telegraphy which now connects the whole civilised world is found in the legislation of Newfoundland, in the intelligent and more than generous encouragement extended to those early movements from which the now world-wide system took its rise. The first project, regarded from the view of later achievements, was a very modest one. It designed to reduce the period of communication between Europe and America by two or three days, by erecting a line of telegraph across the Island of Newfoundland, connected with a short submarine cable to Cape Breton. To this end the Newfoundland Electric Telegraph Company was, at the instance of Mr. F. N. Gisborne, its projector, established in 1852, under charter from the Newfoundland Legislature. This company was succeeded by the New York, Newfoundland, and London Telegraph Company, also incorporated by the Legislature of Newfoundland (subsidised with land grants and money guarantees), which took up the work, and associated with it the idea of an Atlantic cable. This last idea was not realised in fact for some years. In the meantime Newfoundland was the great Transatlantic telegraph post, with headquarters at St. John's, and it became the habit of the mail steamships to call off Cape Race, and then despatch and receive the latest news. Just at the fitting time, and as if the finger of Providence were in it, a United States Naval Expedition in 1853 surveyed the Atlantic bed. The result was to give strength and stimulus to the idea of an ocean cable. Commander Berryman reported thus : 'This line of sea sounding seems to be decisive of the question as to the practicability of a submarine telegraph between the two continents, *in so far as the sea is concerned.* From Newfoundland to Ireland the bottom of the sea is a plateau, which seems to have been placed there specially for the purpose of holding the wires of a submarine telegraph and keeping them out of harm's way.' The report went on to describe the facts more fully, and in them has been found to be the superiority which time ever keeps testing of the Anglo-American and its associated companies' systems over all others. Matter-of-course a thing as ocean telegraphic communication now is, the history of its early difficulties and disasters, and its ultimate triumph when in 1866 the 'Great Eastern' seemed to fulfil her destiny in successfully laying the fourth attempted cable, is a thrilling one, and every man should read it who would learn what intelligent perseverance and indomitable energy are capable of doing in the cause of humanity. To me as a Newfoundlander, who was present at the consummation of this work at Heart's Content, Newfoundland (the only Newfoundlander, indeed, who boarded the 'Great Eastern' as she steamed up Trinity Bay), the memory of the day is one of the most gratifying

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recollections of my life, the more especially as the colony was so honourably associated with this the grandest project of modern times, one which has produced a revolution of the most important kind in commerce and human intercourse—and one which would have been long, and might have been indefinitely retarded but for the liberal and ready aid the colony accorded it. I need hardly observe that by means of the Atlantic cable St. John's enjoys telegraphic communication with all parts of the world ; and I may add that, locally speaking, there is a system of telegraphy most completely connecting the capital with all the principal and numerous smaller settlements, and these with each other, all around the coast."

LEGAL:

Dawson v. The Phœnix Electric Light Company.

This was an action recently brought before Mr. Justice Chitty by Mr. Charles Dawson to set aside a contract under which he took 500 shares in the defendant company; also to recover £250 paid by him in respect thereto, with interest at 5 per cent., from the company and the directors of the company, on the ground that the contract was induced by misrepresentation in the prospectus and fraud.

Mr. ROMER, in opening the case for the plaintiff, said the company was registered on the 16th of May, 1882, and the defendants were the first directors of the company. The auditors were Messrs. Foster, Hight, and Co., and there was an arrangement between them and Mr. Byers, the promoter of the company, which was subsequently ratified by the company, that they should get a commission of 1s. a share for placing the shares for the company ; also that they should have a call of 10,000 shares for a period of seven days, commencing from the 22nd of May. A prospectus was prepared for the company (by whom it did not clearly appear), which was adopted by and issued on behalf of the directors on the 23rd May. The plaintiff received a prospectus and circular shortly after the 25th of May, and thereupon applied for 500 shares, which number was allotted to him on the 1st of June, he paying 5s. a share on them, making £125, and on the 5th July, 1882, a further call of 5s. a share, which made up the £250 in all. In the beginning of July the plaintiff began to suspect the bona fides of the company, and wrote inquiring into its position, but could get no information. He therefore obtained inspection, and then ascertained the alleged misrepresentations in the prospectus, and on the 19th of July the present action was brought. The company had since been wound up. The prospectus said that the company had received offers for the purchase of a concession in England for £40,000, and proposals amounting to £145,000 in other districts. Now, he would tell his lordship what was the alleged justification for the statement as to the offer of £40,000. In the minute book there was an entry as to the proceedings of a Board meeting held on the 22nd May : "The following letters were read and ordered to be entered in the minute book." Among those letters there was one, dated the 15th of May, addressed to Messrs. Byers and Company (the promoters), 54, New Broad-street, from P. Arthur and Co., of 13, Walbrook, in which Messrs. P. Arthur and Co. said that they were willing to enter into an arrangement with them to purchase the sole exclusive rights of their (the company's) patents for the lamps and dynamo machines for the North of England for the sum of £40,000, part in cash and part in shares of a company, provided such company went to allotment. That was really no offer at all, as Mr. P. Arthur rented a garret for four hours each day at the top of a very small house in Walbrook, simply having the right to go there and write his letters. The directors made no inquiry as to Mr. P. Arthur, but yet seemed rather to have doubted the bona fides of the offer, for on the 22nd of May the secretary, Mr. Walter Dunlop, wrote saying the directors entertained the offer, but required a deposit of £1,000, to be lodged with the company's bankers before 2 p.m. on Wednesday, the 24th inst. No answer was received to that letter, and therefore on the 24th the directors knew the character of the offer of £40,000, and yet proceeded to allotment on the 1st of June on the faith of the statements in the prospectus. The £145,000 offer came from a firm of the name of Messrs. Wilkes Brothers, 25, Change-Alley, E.C., who were a very small firm. The directors on the same 22nd May sent a similar letter to that written to P. Arthur and Co. He need scarcely say that nothing came of it. Lastly, there was a letter from a Mr. Prince as to the purchase of concessions, he being "authorised by influential friends." At that time Mr. Prince called himself a patent agent. The result of their inquiry was that they had found out that he had been insolvent six times between the years 1840 and 1868. The directors wrote him a similar letter requiring £1,000 as a deposit, to which, of course, there was no answer. Another statement in the prospectus was that Prof. Varley had said that in his opinion the lamp was superior to all existing incandescent lamps, and he thought that it might be found more durable than any yet known. That statement must have had weight. He found the way Prof. Varley himself expressed himself was as follows :— "I have examined the invention, and though I have not had an opportunity of submitting it to a test of long duration, am of opinion it is superior to any incandescent lamps existing." That was a qualified statement, and somewhat different to the one in the prospectus. Then there was a statement that the company had obtained the power to procure FitzGerald's patents. These patents were a lamp and a dynamo machine, but there turned out to be merely an agreement to purchase one of these. On the 9th May there was an agreement between Jones and Henry, by which Jones sold Henry the patent for £20,000, £4,000 in cash and the rest in shares. Four days aftewards Henry sells it to Waters for £35,000, £15,000 cash, £20,000 shares. Two days after that Waters sells it to the trustees of the company for £70,000, £30,000 in cash and £40,000 in shares. He had one more statement to complain of in the prospectus, viz., that application would be made to the Stock Exchange for an official quotation. His lordship was aware that by the rules of the Stock Exchange, in order to obtain an official quotation, two-thirds of the capital issued had to be applied for and allotted to the public. The nominal capital being £250,000 that would make 83,000 (one pound) shares. The directors, however, proceeded to allotment on 13,686 shares, and no more, for which they received £3,415, with the knowledge that under an agreement of the 9th of June they had immediately to pay the promoters £5,000. In those circumstances the learned counsel submitted that the plaintiff was clearly entitled to recover, the only answer the directors could give being that they really took no trouble in the matter.

Mr. CHAS. DAWSON, the plaintiff, stated that he was induced to purchase the shares by the statements in the prospectus that the company had purchased the FitzGerald patents (both lamp and dynamo), and that they had arranged for the sale of concessions. Paid great attention to the words quoted from Mr. Varley's report. Did not remember having seen Mr. Varley's original report. Applied for the shares on the 24th May. About the time electrical shares were rising fast in value. Had he been told the company had not acquired the patents, but only agreed to purchase them, should not have bought the shares. The paragraph as to the Stock Exchange quotation led him to think that £125,000 worth of shares had been applied for. The prospectus certainly did not say that.

Other evidence having been called bearing out counsel's statement, the plaintiff's case closed.

Mr. WHITEHORN, on behalf of Mr. Garland and Captain Revett, said he might say in the first place that the two directors for whom he appeared were honest persons, who had paid for their shares in the first place, and had not parted with them, neither were they promoters. The prospectus was approved at a Board meeting, held on 22nd May, which was the very one at which they were appointed directors. There was a difference between the directors who prepared the prospectus and those who, though their names appeared on the prospectus, had only become directors after the prospectus had been drawn up.

Further evidence having been taken for the defence, Mr. Justice CHITTY delivered judgment on Wednesday last. He held that the plaintiff failed with regard to the Stock Exchange statement, as it was only a statement of intention to apply to the Stock Exchange; and that he also failed as to the statement with regard to the purchase of the patents. Another and more serious ground was the statement than an offer had been received to purchase the workings of the patents in Scotland for £40,000. To decide this point it was necessary to look at the letters which made the offers, and examining the terms of these he saw nothing inconsistent with the terms of the offers in the statements in the prospectus. Another important point was the statement that "several good offers" had been made. One of the offers had been made by persons calling themselves "P. Arthur and Co.," who were to pay, but did not pay, twelve guineas a year for part of the use of a top room at 13, Walbrook, and these persons could not be found. Another offer came from a man named Prince, who had been twice bankrupt, and had 24 county court judgments against him, and who could not be found. On this ground the plaintiff was entitled as against the company to be relieved of the contract. Then, as to relief against the directors. All four of them were honest men, who had invested their money in the concern, and believed it was sound. The utmost that could be said against them was that they were careless ; but it appeared that they had made inquiries before they joined the company as to the substantiality of the persons who formed it. He thought the case failed as against the directors, but as against the company the plaintiff succeeded, and must be relieved of his contract. The plaintiff would prove in the liquidation of the company for the money paid by him as deposit and calls, and would have his costs.

Mr. ROMER asked if the plaintiff had a right to prove for the money paid with interest at 5 per cent.

Mr. Justice CHITTY acquiesced.

COMPANIES' MEETINGS & REPORTS.

Brazilian Submarine Telegraph Company.

The twenty-third ordinary general meeting of the shareholders in the above Company was held on the 7th inst., at the Cannon-street Hotel, under the presidency of the Right Hon. Viscount Monck.

The SECRETARY (Mr. Richard Collett) read the notice convening the meeting and the minutes of the last meeting. The report of the Directors (which has appeared in *The Electrician*) was taken as read.

The CHAIRMAN observed that at the late Royal Academy banquet several of the speakers bewailed their condition in that they were called upon every year to speak on the same subject, and found it very difficult to produce new matter for the entertainment of the company. He himself felt in a somewhat similar condition, for he appeared before the shareholders every six months to give an account of the transactions of the Company. Those transactions were generally of a monotonous, though he would not say of an altogether uninteresting description, because hitherto, as the shareholders had evinced by their reception on several occasions of the accounts, they were of a very prosperous undertaking. However, when the facts of the case did not

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supply him with straw to assist him in the manufacture of his oratorical bricks, he honestly confessed that he found it rather difficult to make chaff take its place. As to the working of the past half year, he had very often said that it would not be fair to compare two succeeding half years as to revenue, because fluctuations of trade, upon which their revenue depended, caused a much larger income to be received very often in one half of the year than in the other half. Such a comparison would therefore be both fallacious and misleading. The breaking down of the cable in 1883 caused a breach in their receipts which would render a comparison with last year quite impossible and absurd; and he would therefore compare the half year, ending December last with the half year ending December, 1882. Making that comparison, he found that the income of the half year under review had been £817 more than in the earlier period—an increase which was not large, but still, it was an increase, and, taken in connection with the fact that there had been in the meantime a reduction in the tariff, it showed that they need fear nothing with regard to the increase in their trade. Their expenditure stood on a different footing to the revenue, because there was nothing in the circumstances of the case which ought necessarily to make any difference between the amount of the expenditure in the two half years. He found, then, that in the June half of 1884 the net expenditure had been £12,108, and in the December half of 1884 it had been £12,351. These figures had been arrived at by eleminating from the accounts the extraordinary expenses. There had thus been an increase of £243 in the expenses of the past half year as compared with the previous six months, but in that amount was included a payment of £72 for the use of patents. The fluctuation in this item was attributable to the fact that they only paid for the patents when they used them, and their cable having been down in a portion of 1884, the payments on account of patents were so much less in the previous year. The remaining portion of the increase had arisen from small increases of salaries, &c., in London and at the stations. As a company became older the *employés* expected an improvement to be made in their condition, and, beyond that, as the traffic increased, more hands were required. He could, however, assure them that the great object of the Directors—consistently, of course, with securing efficiency of work—was to make the expenses of the Company as small as possible. There was another matter connected with the expenses which he desired to bring before them. They would see on referring to the balance-sheet that £30,000 was due for their new cable to the Telegraph Construction and Maintenance Company at the time of the publication of the report. That amount, he was glad to say, had since been paid, and the cable was now the shareholders' own property, with the exception of the debentures, which he hoped they would pay off in time. Their property was in good condition; they were working well; their revenue showed a slight increase; and he trusted that nothing would occur to prevent their paying the dividends which they had hitherto been able to give. He concluded by moving the adoption of the report and accounts.

The VICE-CHAIRMAN (Sir James Anderson), in seconding the motion, observed, with reference to what the Chairman had said as to the small growth of revenue, that on the previous day he had realised another circumstance to account for this. He found that the Eastern Company were now carrying 100,000 more messages a year, with no more words, and that the Direct Spanish Company were really now carrying three messages for the money which they used to have for carrying one. This was owing to the word-rate and the methods of codifying which the merchants had arrived at, in a manner which he did not think was quite fair, because many of the codes were distinctly illegal. He thought it gratifying, in these circumstances, that this Company stood as well as it did in regard to its revenue.

The CHAIRMAN then put the motion, which was at once unanimously adopted, without discussion; and the proceedings closed with a vote of thanks to the Chairman and Directors.

London-Platino-Brazilian Telegraph Company (Limited).

Report of the Directors for the twelve months ended 31st March :—

The net revenue of the year, after providing for debenture interest and income-tax, is £5,943. 1s. 5d., and £1,005. 4s. 3d. is brought from the preceding year's account, making a total of £6,948. 5s. 8d. to the credit of the revenue account. The interim dividend of 1s. 3d. per share, paid on the 17th November, 1884, absorbed £2,396. 15s., leaving to be dealt with £4,551. 10s. 8d., from which the Directors propose to appropriate £150 in reduction of the item of expenses of issue of the 6 per cent. debentures, and £3,355. 9s. in payment of a final dividend of 1s. 9d. per share, being with the interim dividend at the rate of 1½ per cent. per annum, carrying forward a balance of £1,046. 1s. 8d. The Directors are pleased to remark the increase of traffic over the land lines in Uruguay, the net revenue from this source being £625 more than in the previous year. This increase, however, is more than counterbalanced by the serious decline in the amount received from the Western and Brazilian Company, the amount credited to this Company by that company being £10,655. 4s. 7d., against £12,638. 1s. 9d. in 1884. The difference between the Directors of this Company and the Western and Brazilian Company with respect to this Company's proportion of the receipts for telegrams, referred to in the last report issued by the Board, has not yet been disposed of; meanwhile the amount involved has been kept out of the accounts. The Board are able to congratulate the shareholders on the payment of the arrears of the Government Debt by the Uruguayan Government. As this debt, however, was paid in Bonds at par, their realisation necessarily entailed a loss; but, having regard to all circumstances, the Directors are glad that payment has been effected. It is satisfactory to find that the Government continue to pay for their current message accounts, and it is hoped that such arrears may be avoided in future. The Company's lines are in good working order. According to the Articles of Association, Francis Pavy, Esq., a Director of the Company, retires by rotation, and offers himself for re-election.

COMPANIES' SHARE LIST.

TELEGRAPHS.

COMPANIES.	CLOSING PRICES. MAY 6.		BUSINESS DONE WEEK ENDING MAY 6. Highest.		Lowest.	
Anglo-American	27,	28		28		26
Do. Preferred	47,	48		48		46
Do. Deferred	6½,	6¾		6½		—
Brazilian Submarine	10⅝,	10¾		10¾		10½
Cuba	10½,	10¾		10⅝		10⅝
Do. Preference	17,	18		—		—
Direct Spanish	1½,	2		—		—
Do. Preference	10,	11		—		—
Direct United States Cable	8¾,	9		9		8¾ x.d.
Eastern Telegraph	11,	11¼		11¼		9¾
Do. 6 per Cent. Preference	13¾,	13¾		13⅝		—
Do. 5 per Cent. Debentures, 1899	105,	108		—		—
Eastern Extension	12,	12¼		12 5-16		11¼
German Union	9¼,	9¾		—		—
Globe Telegraph and Trust	6⅝,	6⅝		6⅝		6⅝
Do. Preference	12½,	12¾		12 11-16		12⅜
Great Northern	13,	13½		13 3-16		12½ x.d.
Indo-European	30,	31		28		—
Reuter's	7½,	8		7 9-16		7⅜
Submarine	175,	185		—		— x.d.
West India and Panama	⅜,	1		11-16		—
Do. 1st Preference	7½,	7¾		7⅝		7½
Western Brazilian	5½,	5¾		5⅝		5½
Western Union 7 per Cent. 1st Mortgage	117,	122		—		—
Do. 6 per Cent. Sterling Bonds	100,	103		—		—

TELEPHONES.

Consolid. Telephone and Maintenance	⅜,	½		—		—
Oriental	½,	⅝		—		—
United Telephone	10,	10½		10⅝		9⅝

ELECTRIC LIGHT.

Anglo-American Brush Light (£7 paid)	1,	1½		—		—
Do. (fully paid)	2½,	3		—		—
Hammond Light (£3 15s. paid)	½,	¾		—		—
Swan	½,	⅝		—		—
Maxim-Weston	½,	¾		—		—

MISCELLANEOUS.

Telegraph Construction	33½,	34½		34½		33¾
India Rubber, Gutta Percha, and Telegraph Works	21,	22		21¾		21½

TRAFFIC RECEIPTS FOR APRIL, 1885.

COMPANIES.	April, 1885.	April, 1884.	Increase.	Decrease.
Brazilian Submarine	—	—	—	—
Cuba Submarine	3,700	3,410	299	—
Direct Spanish Telegraph	1,510	1,811	—	301
Direct United States	—	—	—	—
Eastern Extension	41,233	37,044	4,189	—
Eastern Telegraph	63,065	51,975	11,110	—
Great Northern	24,800	—	—	—
Submarine	—	—	—	—
West Coast of America	—	—	—	—
Western and Brazilian	—	—	—	—

GREAT NORTHERN TELEGRAPH COMPANY.—The traffic returns of this company are as follow :—Receipts for April, £24,800; 1st January to 31st April, £89,200; corresponding months, 1884, £81,640; 1883, £77,920.

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The estimated traffic receipts of this company for the half month ended the 30th April are £3,810, as compared with £3,126 in the corresponding period of 1884.

THE WESTERN AND BRAZILIAN TELEGRAPH COMPANY.—The traffic receipts of this company for the week ended 1st May, 1885, were £2,547, after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company.

THE CUBA SUBMARINE TELEGRAPH COMPANY.—The number of messages passing over the lines of the Cuba Submarine Telegraph Company during the month of April was 4,320, estimated to produce £3,700, against 3,801 messages, producing £3,401, in the corresponding month of last year. The traffic receipts for the month of January, estimated at £3,000, realised £3,013.

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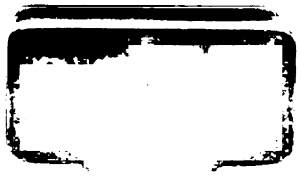

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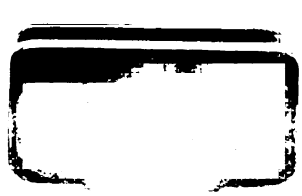

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